Vol. 35/No. 1 April 1968

# Public Roads

## A JOURNAL OF HIGHWAY RESEARCH

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
BUREAU OF PUBLIC ROADS

# Public Roads

## A JOURNAL OF HIGHWAY RESEARCH

**Published Bimonthly**

Harry C. Secrest, *Managing Editor* • Fran Faulkner, *Editor*

April 1968/Vol. 35, No. 1

U.S. DEPARTMENT OF TRANSPORTATION
ALAN S. BOYD, Secretary

FEDERAL HIGHWAY ADMINISTRATION
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BUREAU OF PUBLIC ROADS
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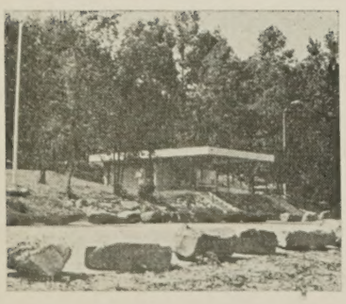

### COVER

Roadside park on U.S. 167 near Salado Creek, south of Batesville, Arkansas.

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Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, March 16, 1966.

**Contents of this publication may be reprinted. Mention of source is requested.**

# Benefits of Highway Beautification

*BY THE OFFICE OF RESEARCH AND DEVELOPMENT BUREAU OF PUBLIC ROADS*

**Reported by FLOYD I. THIEL and JOHN YASNOWSKY, JR., Economists,[1] Economics and Requirements Division**

***The Congress expected the overall benefits of the Highway Beautification Act of 1965 to exceed the costs; but it requested additional information on the benefits and on the costs of carrying out the provisions of the act to provide a basis for future decisions on the beautification program.***

***Much information has been gathered on the direct financial costs of the program, and much has been learned about indirect costs in terms of the impact on the individuals and groups who expected such adverse effects from the act as short run losses that could be encountered by some outdoor advertising companies and roadside businesses. The benefits of the act have received little attention, perhaps partly because they are largely intangible and difficult to evaluate and measure. Despite this difficulty, decisionmakers must have some knowledge of the benefits and the costs if they are to make meaningful decisions.***

***In this article the authors emphasize the benefits of the beautification program and, in doing so, give little attention to the costs and the adverse effects of the act. However, there is no intent to imply that losses will not be incurred by some groups. The primary purpose of this article is to fill a gap that has existed concerning the nature and extent of the benefits to be expected from the beautification program.***

## *Introduction*

CONGRESSIONAL DECISIONS to undertake such programs as highway beautification require information about the benefits and costs of these programs. This need exists whether the information is provided explicitly in the form of a benefit-cost analysis or in some such form as a study of costs or of economic impact.

The Congress obviously felt that the benefits of the Highway Beautification Act of 1965 would outweigh the costs. In passing the act, the Congress recognized a need to learn more about the costs, the economic impact, and the public and private benefits of the act. To obtain information on these matters, the Congress requested a study of the beautification program.

Learning about the costs of the beautification program has presented no insurmountable problems; accordingly, at this point, information about the costs, including indirect costs, appears to be adequate. Information about the direct costs of the program, and of alternate programs, has been provided in a fairly comprehensive study conducted cooperatively by the State highway departments and the Bureau of Public Roads. Additional information about estimated costs has been provided by groups affected by the act, particularly members of the outdoor advertising industry.

The benefits of the highway beautification program can be estimated, at least in a general way, but these benefits cannot be quantified or described with the precision possible in dealing with money. In the study of the economic impact of the act (*1*),[2] which the Bureau of Public Roads conducted in cooperation with several State highway departments, the difficult problem of measuring benefits of highway beautification is recognized. In spite of the problems, some effort to evaluate the benefits must be made if meaningful decisions are to emerge.

Benefits of highway beautification were described not only in the Bureau's beautification impact study, but also in many of the 25 studies of the economic impact of the Highway Beautification Act conducted in many States throughout the country. These studies are listed at the end of this article. The need for information about benefits was underscored by a Congressional request at the 1967 House hearings on highway beautification. The discussion in this article, drawn from the Public Roads report of the economic impact study, is based partly on the attention that the Congress has focused on the need for information about benefits. The benefits referred to for one group, such as motorists, may be costs or disadvantages for others, such as outdoor advertisers. Some of the benefits referred to result from adjustments by those affected by the program rather than from beautification itself, and most of the benefits will occur only when the act becomes operational. Though these benefits are intangible and largely unmeasurable, they can be conveniently described when classified as: (1) General or overall benefits, (2) benefits from scenic enhancement, (3) benefits from outdoor advertising control, (4) benefits from junkyard control, and (5) benefits perceived by considering costs on a unit basis.

## *General or Overall Benefits*

The overall benefits of highway beautification go primarily to people using the highways. The benefits anticipated include increased comfort, pleasure, convenience, and safety while traveling. Additional general or overall benefits that go beyond those resulting directly from scenic enhancement, billboard control, and junkyard control include: (1) An increased consciousness of the need for preserving the Nation's scenic resources, (2) the beneficial effect the highway beautification program will have on national and local economies, especially on local economies, and (3) the benefits resulting from the permanence of most highway beautification measures.

### Increased interest in scenic resources

The current interest in the quality of the environment in the United States is unmistakable. Increasingly, the problems in this country are concerned with the quality of living rather than the amount of resources. "More and more people are concerned with water pollution, air pollution * * * solid wastes, the preservation of areas for outdoor recreation and for open space, the design and arrangement of both the urban and rural landscape. * * * Living in harmony with nature has become a matter of conscious attention and national policy. * * *" (*2*). Clearly, "there are strong indications of an awakening public appreciation of the amenities and acceptance of responsibility for preservation of our vanishing resources, the Nation's landscape" (*3*).

The Highway Beautification Act of 1965 cannot be properly credited with creating the current interest in esthetic highways or in environmental quality generally, but it can be credited with intensifying this interest. The act is focusing attention on "an often neglected aspect of highways".[3] News stories have

[1] Alice C. Randill, James M. Montgomery, Anthony T. Cluff, and Edward M. Nolan also contributed work on which this article was based.

[2] Italic numbers in parentheses indicate references listed on page 8.

[3] From remarks by John T. Connor, former Secretary of Commerce, prepared for delivery before the Highway Transportation Congress, Washington Hilton Hotel Apr. 13 1966.

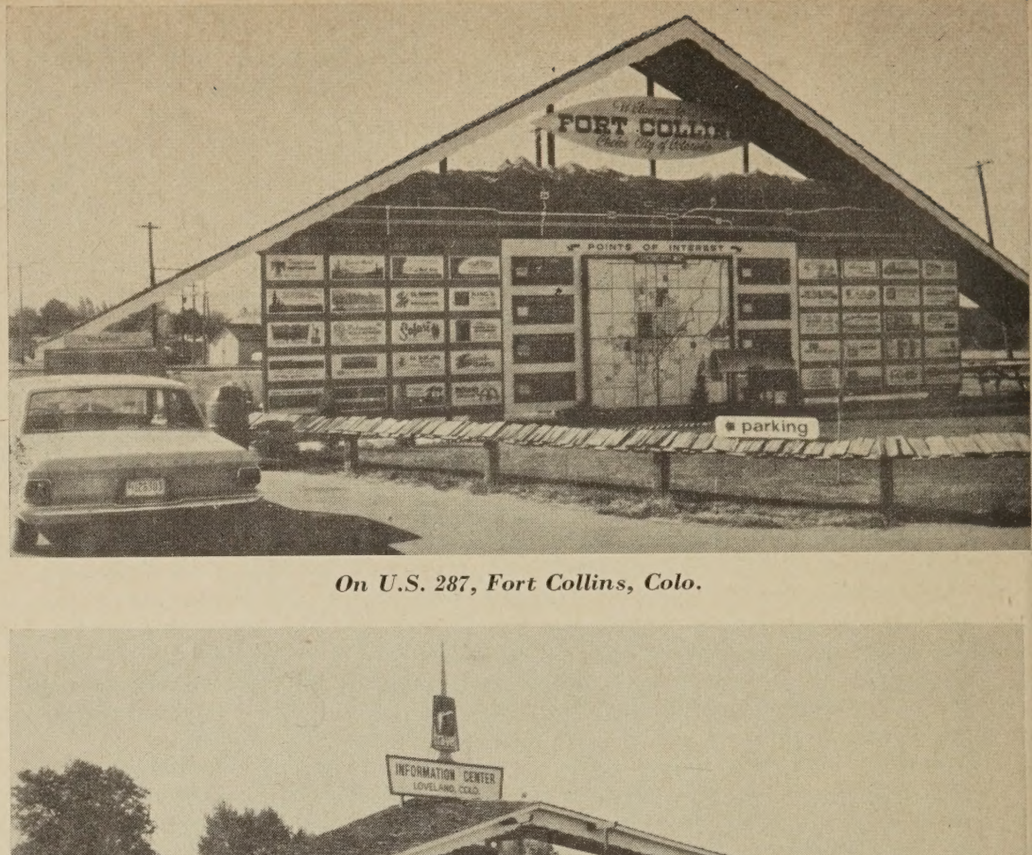
credited the highway beautification program with adding impetus to such developments as: (1) Oil company efforts to design their service stations to blend with the scenery, and (2) attempts to protect trees by barricades during construction. An increase in subscriptions to the magazine *Landscape Architecture* has even been associated with the highway beautification program.

### Effects on local economies

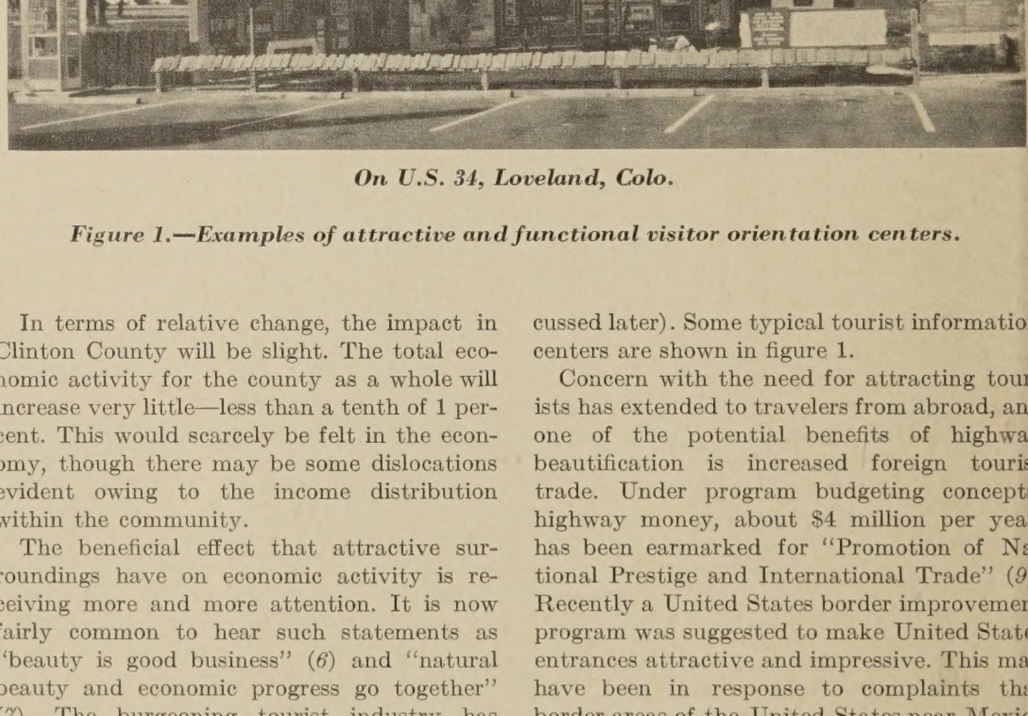
The economic stimulus provided by expenditures for highway beautification—that is, landscaping, screening, etc.—is fairly obvious. Although the effect on economic activity is generally less for highway expenditures than for other public expenditures where labor costs are more important, $1 spent for highway beautification will ordinarily result in total economic expenditures of more than $2 (*4*). This economic activity, though a benefit to some who are directly affected, results from the cost of the program. When the cost is borne by taxes, it will tend to offset the economic stimulant provided by the spending, at least on a national basis. Whether this economic activity produces a gain in national wealth or production depends on whether the taxing and spending for highway beautification result in the use of previously unused resources or in a more productive use of resources that were previously used.

It is not entirely clear whether the expenditures for scenic enhancement and junkyard control will stimulate economic activity sufficiently to offset the economic activity lost because of signboard removal. If, as is anticipated, an investment in landscaping or other comparable highway beautification projects encourages tourism, enhances land values, and eases driver tension, then the investment in highway beautification should yield economic gains comparable to those that were lost after removal of some billboards. This will be particularly true if, as is possible under the Highway Beautification Act, substitutes for commercial billboards, such as information centers and official right-of-way signs, are provided for the motorist.

Whether the gains will exceed the losses cannot be estimated with certainty at this time, but considerable insight into the matter has been provided by a study of the economy of Clinton County, Pa., in which an input-output model was used to provide forecasts such as the impact of highway construction and the effects of a strike at a local aircraft plant (*5*). The major finding from the study was the forecast that the county would experience a slight increase in economic activity as a result of the Highway Beautification Act. Apparently, counties like Clinton County that have no local outdoor advertising companies may experience less effect from the billboard control provisions than counties that have such companies. Of the 3,000 counties in the Nation, there may be a number with no outdoor advertising companies headquartered within their borders as the approximately 3,500 outdoor advertising companies tend to be grouped in counties with large cities.




*On U.S. 287, Fort Collins, Colo.*




*On U.S. 34, Loveland, Colo.*

***Figure 1.—Examples of attractive and functional visitor orientation centers.***

In terms of relative change, the impact in Clinton County will be slight. The total economic activity for the county as a whole will increase very little—less than a tenth of 1 percent. This would scarcely be felt in the economy, though there may be some dislocations evident owing to the income distribution within the community.

The beneficial effect that attractive surroundings have on economic activity is receiving more and more attention. It is now fairly common to hear such statements as "beauty is good business" (*6*) and "natural beauty and economic progress go together" (*7*). The burgeoning tourist industry has helped focus attention on the connection between pleasant surroundings and economic progress. Increasingly, communities are emphasizing their pleasant scenery in an effort to attract tourists. More and more, there appears to be agreement that cities need to "make a charming entrance" to "draw tourist dollars" (*8*). To help provide a pleasant entrance and to assist travelers, visitor information centers are being used in many locations. These are compatible with the highway beautification program, which provides for the use of information centers at safety rest areas (discussed later). Some typical tourist informatio centers are shown in figure 1.

Concern with the need for attracting tou ists has extended to travelers from abroad, an one of the potential benefits of highwa beautification is increased foreign touri trade. Under program budgeting concept highway money, about $4 million per yea has been earmarked for "Promotion of N tional Prestige and International Trade" (*9* Recently a United States border improvemer program was suggested to make United Stat entrances attractive and impressive. This ma have been in response to complaints tha border areas of the United States near Mexi are becoming shabby.

The increased opportunities that scen highways may offer for business activity a offset to some extent by losses in other area For this reason, highway beautificatio whether along the highway or on priva property bordering the highway, may n produce any substantial increase in reven to the tourist industry on a national basi However, to the extent that foreign travele can be encouraged to travel in America, that Americans can be encouraged to trav more in this country, a gain in revenue

epresented for the tourist industry. Such a ain still may not constitute a gain in national ncome if it is offset completely by a loss in ther sectors of the economy. Ordinarily, here there are some unused resources, any ain to the tourist industry from domestic ravel would be partly, but not completely, ffset by losses in other sectors of the economy (*10*). Experience abroad may provide some nsight into the relation between scenic ighway and business experience. England nd Switzerland with "more or less stringent ystems" have been contrasted with Italy nd Belgium, which Nairn rates "bad as merica" with respect to roadside esthetics. Nairn suggests that the pleasing roadsides n England and Switzerland have been asso iated with business activity just as much as he roadsides in Belgium and Italy where oadside advertising is common.

Although most of the features of the High way Beautification Act should encourage ourist travel and business related to high way travel, some affected businesses may not enefit. For example, safety rest areas tend o encourage highway-oriented business by naking travel pleasant and safe. This should timulate business. But rest areas also make t more convenient for motorists to picnic long the way, which may have an adverse ffect on roadside restaurants.

### The permanence of highway beautification

The benefits that highways, especially ontrolled-access highways, can yield as lividing lines or buffers between different and uses have been well established. Con rolled-access highways are especially effective or this purpose, because of their perma nence—their built-in resistance to obsolescence. Highway beautification enhances this feature f controlled-access highways.

Highways, like most other tangible objects, wear out over a period or become inadequate for the required service. Even highway right f-way must be regarded as having a definite ife, though right-of-way does ordinarily have longer life than surfaces or structures. The fact that physical things will wear out and hat benefits of the project will decline over the years obviously must be considered by decisionmakers when they evaluate the bene fits and costs of investments, including Government investments. Because of this tendency for benefits to decline, it is ordinarily proper to base the evaluation of projects on economic life rather than on physical or use ful life. Thus, even though right-of-way for a highway may have an unlimited physical life, it is better to consider the probable economic life (*11*, *12*); for example, the economic life for rural Interstate highways is often esti mated to be 35 years for road surface, 65 years for structures, 80 years for grading, and 100 years for right-of-way.

With the exception of junkyard fencing and certain plantings that may not survive, most highway beautification measures should be quite enduring, possibly as enduring as the right-of-way. Some of the benefits of highway beautification may extend even beyond the economic life of the right-of-way as, for example, when the beautification occurs in areas where at least some of the benefits, such as the parklike effect of a well-landscaped open space, continue even after the highway is abandoned.

Although well-designed and well-located highways may have longer duration than the buildings or other manmade structures nearby, it is possible to surround highways with an environment that will be long lasting. The early parkways did this. In fact, the landscaping along some of these parkways has outlasted the roadway itself. The potential benefit of highway surroundings that protect the highway from undesirable encroachments has, of course, been recognized for some time. A 30-year-old report states that "Parkways will benefit future generations as well as the present. Parkways have great duration, though the surface may wear out several times" (*14*).

The permanence of highways with parklike surroundings results primarily from the way in which time affects different elements of the highway and the highway environment. Pavement and buildings grow older and deteriorate according to historical time, but a landscape with a minimum of care regenerates itself by the process of nature—the cycles of day and night and the seasons. The value of having parklike landscaping along highways may become even more pronounced in the future. Some of the current practices not only tend to simplify maintenance, as noted below, but emphasize practices that may foster this regenerative aspect of natural landscaping—no-mow ground covers, small plantings that may reseed themselves, uneven rows or clumps of plantings so that replacements are not necessary (*15*, *16*).

## *Benefits From Scenic Enhancement*

Scenic highways provide benefits to at least two groups: Highway users and nearby landowners. Esthetic landscape design typically enhances the motorists' safety and enjoyment, and stabilizes community desirability and property values. Roadside beautification is really just another way of striving for the *complete highway*—a highway that incorporates its esthetic factors in the abutting landscape corridor and thus contributes to highway safety, economy, and utility, and to the esthetic character of the corridor itself. When combined with rigorous engineering standards, highway beautification makes pleasure driving more enjoyable, but does not impair the highway's usefulness for commercial or other types of traffic.

### Highway user effects

Surveys of motorists' desires show that scenic, or beautiful, highways are preferred by nearly all highway users. Some motorists have such a strong preference for scenic routes that they will travel farther or longer to traverse a scenic highway. In one survey scenery was rated as more important than travel time or distance but less important than congestion. Scenery was rated highest for pleasure driving with no particular destination and for driving to vacation destinations. Apparently, the more time a motorist has to spend on his trip, the more he is likely to select a scenic route (*17*).

### Land values

The pleasure that scenic highways or parkways are meant to generate is reflected, at least in a general way, in the development of land and near these facilities in the land value. Land values provide a fairly objective measure of the economic potential of a piece of property or of an area;[4] land values can be an indicator of "all the various direct and indirect impacts".[5] They ordinarily reflect changes affecting property, whether there is a favorable influence such as a school, a park, a parkway, or a scenic highway, or whether there is an adverse influence such as a noisy, dangerous traffic arterial, or the presence of air pollution. Land values have been a useful tool in assessing the effects that water resources, urban renewal, recreation, parks, highways, and other projects have on nearby or other affected areas (*18*). Although many of these effects might have been merely attracted rather than created by the parkway or other project, there is considerable agreement that well-conceived and well-located projects may be associated with land value gains—owing to increased economies and efficiencies—that will not be offset by losses elsewhere.

Though improved esthetics or visual quality appear to be the primary purpose of scenic highways, these facilities also produce economic benefits. This generalization can be made on the basis of analogous experience with parks and open space, on the strong preference which prudent real estate investors have for pleasant surroundings, and on the persistent economic well-being which has been associated with parkways.

### Parks, open space, and parkways

There is general recognition of the beneficial influence that parks and open space can have on nearby areas. The benefits of parks and open space, or least some of them, accrue to nonparticipants, to people passing by the park, and to residents living near the park who may never make any direct use of it. This park effect typically shows up in increased land values nearby. In Washington, D.C., for example, parks have been credited with enhancing nearby property values to such an extent that the resultant increase in property taxes has far exceeded maintenance and operating costs of the parks (*19*). Experience in Boston further illustrates the beneficial effect of a park or open space used in connection with a highway. Properties

[4] Land values tend to be more objective than some indicators, such as opinion surveys, because land values avoid most of the problems associated with interpreting the real attitudes of respondents; land values are based on verifiable contracts rather than on statements or responses that may sometimes be self-serving or otherwise inaccurate.

[5] From remarks by Allen V. Kneese, Resources for the Future, in his unpublished paper *What are We Learning from Economic Studies of Environmental Quality?*, p. 9.

along the Charles River and near Jamaicaway where the parkway widens to encircle Jamaicaway have benefited; this is in contrast to areas near South Bay and Dorchester Creek where streets and highways have not been protected by sufficient space or parkland and have not benefited (*15*).

Private developers make good use of the tendency of open spaces, parks, and parklike highways to enhance values of nearby land. In Los Angeles, where the Hollywood and Santa Ana freeways were constructed through areas covered by old buildings that had to be removed, plantings so improved the general tone of the neighborhoods that owners have been stimulated to renovate, reconstruct, and develop their properties (*20*). Many developers find that the income foregone by keeping certain areas untouched is more than recovered by the higher prices received for those properties that sell.[6] One developer is even going to an expense of $15,000 an acre to *wipe out commercialism.* The benefits that *a beautiful parkway* provides for his development are obvious to this developer (*21*).

The benefits realized from parks, parkways, and trees and other plantings on public space is fairly understandable. Scenery has value and can be enjoyed whether trees and plantings are owned by the public or by individuals. Trees along the highway can be enjoyed by many people and may possess even greater value than trees on private property. Such trees obviously must be located far enough away from the highway to avoid being a hazard to highway traffic.

### Experience near parkways

Parkways, or scenic highways, have some of the characteristics of parks and some of the characteristics of highways. A recent study in the Washington, D.C. area has provided a comparison of land values near parkways and other highways (*22*).[7] In the period 1950–60, parkways generally outpaced nonparkways both in land value changes, adjusted for general price changes, and in the share of Washington's development of areas near parkways and nonparkways. For example, the corridors along the George Washington Memorial Parkway in Virginia (fig. 2) and the Baltimore-Washington Parkway in Maryland (fig. 3) have developed at a faster rate and have had higher increases in land value than has the corridor along Shirley Highway. Property values near parkways and other highways in the Washington, D.C., metropolitan area are shown in table 1 for the period 1950–60.

*Figure 2.—Scenic area of George Washington Memorial Parkway in Virginia.*

A comprehensive study of parkways and land values, completed several years ago, showed that parkways in the vicinity of New York, Boston, and Kansas City were economically sound. Land values in the areas affected, taken to be "the measure of the real estate's possible benefits to the available purchaser who can make the most profitable use of it" (*23*), increased substantially.

### Experience near other scenic highways

A recent attitude survey in Chicago indicates how nearby residents feel about some of the newer highways where attention has been given to making them esthetically pleasing. In response to the somewhat leading question, "Do you consider the expressway a thing of beauty?" the responses were "yes" from 70 percent along the Edens Expressway, 100 percent along the Kennedy Expressway, and 80 percent along the Eisenhower Expressway. Open-cut areas of greenery were generally preferred to close neighbors, and the Eisenhower Expressway was considered a factor in revitalizing the slum area nearby. Some residents regarded the expressway as their park, to be enjoyed visually, even though they did not physically enter the area (*24*).

### Local tax base effects

Some of the effects that the Highway Beautification Act may have on local tax bases have been referred to, at least incidentally, in the discussions of land values, business activity, and input-output model. Scenic enhancement provisions should be beneficial for local tax bases, but some adverse

**Table 1.—Property values near parkways and other roads in the Washington, D.C. area—1950–60** [12]

| Types of highway | Adjusted value per square foot | | Gain 1950–60 | |
|---|---|---|---|---|
| | 1950 | 1960 | Dollars | Percent |
| Parkways: | | | | |
| George Washington Memorial Parkway | $0.18 | $0.81 | +0.63 | 350 |
| Baltimore-Washington Parkway | 0.40 | 1.38 | +0.98 | 245 |
| Rock Creek and Potomac Parkway | [3] 9.14 | 10.35 | +1.21 | 13 |
| Other roads: | | | | |
| Shirley Highway | 0.41 | 0.74 | +0.33 | 80 |
| Seven Locks Road [4] | 0.04 | 0.35 | +0.31 | 775 |
| Old Dominion Drive | 0.54 | 1.21 | +0.67 | 124 |

[1] Source: D. L. Ames and J. T. Davis, *Parkway Impact Study, An Investigation of the Effects of Parkways in the National Capital Region,* George Washington University, Washington, D.C., 1962. Property values include land and improvements. Assessments, verified by some market sales, were used in the study. Each of the study areas has a minimum extent of either six properties or 2,100 feet from the right-of-way.

[2] Types of traffic were not analyzed in this study. Research now underway, such as the "Effect of Highway Landscape Development on Nearby Property" by Franklin Institute Laboratories, a study that is part of the National Cooperative Highway Research Program, may ascertain the extent to which parkway effects are due to the absence of noisy truck traffic as well as to the presence of landscaping.

[3] Values are for 1945. Developments near the Rock Creek and Potomac Parkway appear to look to other major streets in the area for their access to community services and places of employment. The study area (from M Street to Calvert Street and from 31st Street to Florida and Connecticut Avenues) included some of the highest valued properties in the District of Columbia as well as some of the lowest.

[4] The increasing share of Washington's development which the area near Seven Locks Road experienced apparently results largely from: (1) Change from farm to vacant or residential, (2) speculative activity in anticipation of the Capital Beltway, and (3) the spatial association of residences with Burning Tree Country Club, and Bradley Boulevard.

[6] From remarks *Toward Measuring the Intangible Values of Natural Beauty,* by Judith M. Huff and Hugh A. Johnson, U.S. Department of Agriculture, presented at annual meeting, Soil Conservation Society of America, Albuquerque, N. Mex.

[7] Although some of the growth near the Baltimore-Washington Parkway may result from such nonroad influences as greater economic development in the direction of Baltimore, the use of the so-called participation ratio generally adjusts those nonhighway influences that were present at the beginning of the study period in 1950.

*Figure 3.—Planting shrubbery along the Baltimore-Washington Parkway in Maryland.*

effects may be experienced by local taxing jurisdictions where scenic easements retard development. Such restrictions may occasionally divert development to other taxing jurisdictions, but ordinarily, scenic easements will only cause whatever development that occurs to be removed farther from the highway. Some adverse effect may also result from the removal of property from tax rolls because of the acquisition of additional land for scenic strips. Both of these possible adverse effects should be minor and more than offset by general enhancement of tax rolls because of the act, but no concrete evidence of this is now available.

Junkyard control provisions are expected to result in a general improvement of local tax rolls. This is discussed later. Billboard control provisions will also have some effects on local tax rolls. Based primarily on information and comments supplied by analysts involved in State studies, it appears that local tax authorities seldom collect taxes on sign structures owned by advertisers such as motels and restaurants. The number of these signs is approximately one-half of all the signs along the highways. Property taxes ordinarily are collected for signs owned by advertising companies, but apparently not in all taxing jurisdictions. It seems obvious that no decrease in local property tax revenues will result from the loss of sign structures for which no local property taxes have been paid. In fact, if the highway payments made for sign structures are invested in some form of property that is taxable—for example, in improving the appearance of the *plant* by landscaping or by a larger on-premise sign—local property tax rolls might be benefited by the beautification program. To the extent that the removal of signs lowers revenue produced by State or local sign licenses or fees, the act may have an adverse effect. This should be very minor as these fees are usually nominal.

The effect that billboard removal might have on land values and taxes appears to be minor. Some State researchers have found that local tax assessors typically assess land on its value in a nonbillboard use so that sign rental or its loss has no effect on taxes. Although there are indications that the value of some land parcels might increase if billboards on the parcel and on land nearby are removed, there are no definitive findings yet available to support this fact.

**Maintenance benefits**

Good landscaping often eases maintenance problems and costs. In Ohio, "expenditures for roadside development, flattening and rounding slopes, seeding, landscaping, and erosion control have provided handsome returns in reduced maintenance expenses* * *." (*3*). The possibility that highway beautification can save money on maintenance was also referred to at a recent Ohio State University symposium. Savings in maintenance operations result from functional plantings that save mowing, reduce headlight glare, hide litter, abate noise, guide drivers, screen undesirable views, and serve as snow fences. Living snow fences have saved up to $500 per mile in maintenance costs.[8]

It is obvious that some aspects of well-landscaped highways raise, as well as lower, maintenance costs. Rest areas, for example, often create serious maintenance problems caused by vandalism.[9] Yet rest areas lower costs for such important maintenance items as litter control. This is shown by the heavy use of litter barrels at rest areas. Surveys of facilities used at rest areas demonstrate the importance of making trash barrels easily accessible—as many as 16 barrels of trash are collected each day from some rest areas. Though disposing of this volume is a major task, it is much more economical to handle rubbish in barrels than when it is scattered along the roadsides. Even if the barrels are used for domestic garbage, it is still better to have it there than in a ditch (*25*). Also, providing pleasant and neat roadsides with adequate rest areas, which are equipped with trash receptacles, should influence more motorists to keep these well-landscaped highways neat.

## *Benefits From Outdoor Advertising Control*

Benefits from the control of outdoor advertising will accrue primarily to roadside businesses, landowners, local communities, and outdoor advertising companies. Outdoor advertising companies, for instance, will experience tangible benefits that will offset some of their losses from sign control. The industry itself recognizes that heavy concentrations of signs reduce the value of each individual unit, and that fewer signs per mile increase the profitmaking ability of each sign. The Traffic Audit Bureau, an organization supported by both advertisers and outdoor advertising companies, considers proximity to other structures a disadvantage when auditing the *space position value* of a sign. Some executives of companies using outdoor advertising have recently warned that many sign locations are becoming overcrowded and are therefore reducing the value of all signs at these locations. Also high gross receipts per outdoor advertising establishment have been associated with, but not necessarily caused by, low sign densities. The State of California, where outdoor advertising signs have been controlled for years, ranks among the States that are lowest in signs per mile of highway, but highest in gross receipts per outdoor advertising establishment.

*Roadside business establishments* may also experience gains from outdoor advertising control that result from a reduction in unnecessary advertising costs. Some roadside business operators use off-premise outdoor advertising signs only because their competitors do. In a study by New Mexico State University, it was found that several motel managers would be willing to remove their off-premise signs to save the amount being spent on outdoor advertising, provided that their competitors did likewise.

*Landowners* are also benefited by outdoor advertising control. In some places the removal of commercial signs will make the area more attractive, thus permitting higher and more profitable types of development. Also, some landowners in commercial and industrial areas, where signs are permitted, may find that their land has become more

[8] From remarks *Feasibility of Incorporating Natural Beauty Into Highway Design*, by Robert F. Baker, delivered before Symposium of the Ohio State University, Natural Resources Institute, Columbus, May 1966.

[9] For this vexing problem, the vandal-proof comfort stations announced in *Public Works*, vol. 97, No. 3, March 1966, p. 48, may provide a solution.

valuable as a sign site and may receive an increase in rental income. This increased value will result from the decreased supply of land for signs, and it is probable that the scarcity of land will promote signs of a higher quality to increase their effectiveness. With only a limited number of signs permitted, it would be uneconomical for an outdoor advertising company to maintain unsightly and ineffective signs. An indirect effect of the improvement in quality could be an increase in landowner income.

The benefits that *communities* receive from outdoor-advertising control include the improved opportunities for business afforded by attractive surroundings. For example, one testifier, at the Arizona hearings on beautification standards in March 1966, stated: "Since the removal of the off-premise billboards, none of the well-established businesses in the area have felt any 'pinch.' I can honestly say that business has been *up* in our area. In all ways we business people of Sedona-Oak Creek Canyon have felt that in doing away with the billboards we have enhanced our businesses, our community, and our way of life."

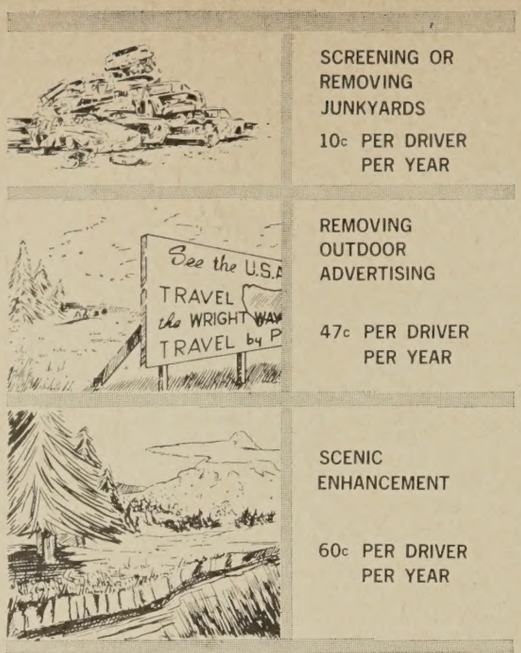

SCREENING OR REMOVING JUNKYARDS
10c PER DRIVER PER YEAR
REMOVING OUTDOOR ADVERTISING
47c PER DRIVER PER YEAR
SCENIC ENHANCEMENT
60c PER DRIVER PER YEAR

*Figure 4.—Highway beautification costs over a period of 20 years.*

**Official information centers and right-of-way signs**

The writers of the Highway Beautification Act of 1965 were fully cognizant of motorists' needs for information and provided for the construction of information centers, which will be beneficial to motorists, roadside businesses, local communities and even to outdoor advertising companies. Information centers, built with both private and public funds, have been important aids to the States' economies as well as new sources of business to hotels and motels.

Many advantages of information centers over off-premise commercial signs are realized by a tourist-oriented business. First, information centers may be more effective in communicating with the traveler; they enable the businessman to tell his full story about the facilities he has to offer, about his rates, and sometimes even about vacancies. Second, the cost of advertising is substantially less; example, the cost of a sign at the information center in Aspen, Colo., is $12 initially plus $24 per year, whereas costs for advertising on off-premise signs are usually much higher. Third, the advertiser does not risk losing those customers who might be opposed to signs along a highway.

In addition to information centers, official signs on the right-of-way of interstate highways, evolving from the highway beautification program, may provide tourist-oriented businesses with opportunities to communicate with motorists. A demonstration project conducted along Interstate Highway 95 in Virginia showed amply how official signs can benefit roadside businesses. The study revealed that of 578 customers, 97 percent of the gasoline customers, 89 percent of the food customers, and 93 percent of the lodging customers indicated that the specific information signs had met their needs. The researchers covered several of the signs advertising gasoline stations to test their usefulness. In almost all cases, the quantity of gasoline sold by the stations listed on the information signs was greater when the signs were exposed than when they were covered.

Official information centers and right-of-way signs provide an excellent alternative source of income for outdoor advertising companies that will lose under outdoor advertising control. The manufacture, erection, and maintenance of signs and other materials at information centers, for example, can probably be accomplished best by the skills and business experience of established outdoor advertising companies. Several outdoor advertising companies have shown an interest in providing advertising services of this type or are already engaged in them. One company has recently erected a building in Iowa to provide the types of information needed by the traveler, including points of interest and information about health and emergency and personal services. Information of this type cannot readily be obtained from off-premise billboards as they now exist. The company, in suggesting the important qualifications that experienced outdoor advertising companies should have to provide information center services, stated: "The role of an experienced, private business * * * is vitally important because of the demanding service requirements of highway advertising. * * * Changes in advertising messages require personal contact with the advertiser * * * finished art, production and placement of the changed advertisement. A private advertising service company is staffed and equipped to perform these services."

The state of uncertainty that has existed in the outdoor advertising industry is another reason that investment in information centers or right-of-way signs would be advantageous. Advertising through information centers and by right-of-way signs seems to be well accepted by advertisers, by the local community, and by the traveling public. This has not been true with off-premise signs and billboards. For many years, local and State governments have been enacting legislation to eliminate off-premise signs. Many garden clubs and other groups have been opposed to this type of advertising, and advertisers have been aware of this public reaction. By investing in information centers which are desired and needed by the traveling public, the industry could find itself in a more stable environment.

## *Benefits From Junkyard Control*

As with outdoor advertising control, the primary benefits of junkyard control are experienced by the motoring public in the form of increased driving pleasure. However, some tangible benefits will also accrue to junkyard operators, landowners, and businesses supplying goods and services for screening junkyards. A better public image resulting from junkyard screening will be the main benefit to junkyard operators. This is supported by a finding in a study, conducted by Pennsylvania State University, in which several of the larger junkyard operators interviewed generally favored the Highway Beautification Act because they felt that screening would result in better public relations.

Junkyard control provisions are also expected to enhance property values and therefore tax rolls, as mentioned previously. This is particularly true for screened junkyards. Several qualified analysts believe screening will improve neighborhoods and land values near screened yards. Relocated junkyards may result in tax gains for some jurisdictions and in losses for others. Relocation may produce a tax loss from relocated junkyards that previously paid taxes and that cannot survive a move, but new activities appearing at the sites vacated by junkyards may have higher incomes and produce more taxes than the displaced junkyard operations.

## *Benefits Perceived Through Unit Costs*

As suggested, the benefits of the highway beautification program should exceed the costs. In the absence of precise information about benefits, costs can sometimes be described or restated in terms that permit decisionmakers to compare benefits and costs in an effective way. For example, the costs of highway beautification were at one point estimated to be approximately $1.17 per driver per year, with total costs amortized over a 20-year period at 6-percent interest compounded annually, and divided among 99 million drivers. The costs per driver per year are shown in figure 4, but should actually be somewhat less because (1) these unit costs were derived from the relatively expensive program under consideration in early 1967 and (2) in the future there will be more than the present 99 million drivers to share these

*Figure 5.—Snow Falls rest area on Route 26, West Paris, Maine.*

*Figure 6.—Rest area on I-95, southbound, near Pittsfield, Maine.*

costs. Also, unit costs should be substantially less if passengers as well as drivers were considered.

**Rest area benefits**

The benefits derived from rest areas are substantial, but whether they are as great as the cost is a matter that must be considered. Under the highway beautification program, rest areas on the Interstate system will cost about $150,000 each to construct. Based on incomplete information, the 2,500 rest areas along the Interstate system may attract between 5 and 14 percent of the traffic passing by these facilities. If the percentage of vehicles stopping is as low as 5 percent, costs would amount to less than 5 cents per car for each visit, assuming a 20-year life for the rest areas. Examples of the use of rest areas by the traveling public are shown in figures 5 and 6.

Some insight may be gained concerning the value visitors place on these stops by considering the amount of time they spend at rest areas. Very incomplete data indicate that visitors usually spend about 15 minutes each time they stop at rest areas. Motoring for pleasure has sometimes been valued at about 36 cents per person per hour, a figure derived generally from the vehicle operating cost divided among the people in the vehicle traveling for pleasure (*11*).[10] Assuming that people traveling for pleasure do value motoring at 36 cents an hour, it seems that they are placing considerable value on rest area stops. Each time a pleasure traveler stops for 15 minutes, he is apparently foregoing, or at least postponing, travel that he values at about 9 cents.

### *The Cost of Pleasure Driving*

Considering the cost of pleasure driving provides some insight into the benefits yielded by highway beautification. Motor-vehicle-use studies have shown that at least 12 percent of the automobile travel in the United States is for pleasure. This means that approximately 90 billion vehicle-miles were driven for pleasure in 1966 (12 percent of the 750 billion vehicle-miles traveled on all highway systems) when traffic volumes were considerably lower than they are at present. If each motorist was aware that his variable or operating costs were approximately 6 cents for each mile traveled, it follows that the motorists traveling the 90 billion vehicle-miles for pleasure placed a high value on this travel by paying more than $5 billion per year to engage in pleasure driving. A comparison between this cost and the estimated yearly costs for beautifying the highways would not indicate whether the amount planned for highway beautification is appropriate; but the magnitude of the cost of this pleasure-driving does indicate the resources motorists are willing to commit to pleasure driving.

### *Summary*

The expense of highway beautification has received much attention, and the study completed cooperatively by the States and the Bureau of Public Roads has provided specific information about the costs of the program. Other material pertaining to costs, including estimates of indirect effects, has been made available to the Congress by various groups, some of which are affected adversely by the act.

The discussion in this article is limited to the benefits of highway beautification. It is intended to provide information to complement that already available on costs. Hopefully, this description of some of the benefits of highway beautification will be useful to decisionmakers in weighing the costs and benefits of the program.

Benefits of the program are substantial and significant, but they are also largely intangible and unmeasurable. Their illusive nature

[10] The 36 cents-per-hour estimate may understate the value motorists place on pleasure driving, as (1) it was based on a traffic speed of about 25 m.p.h., which is lower than current traffic speeds, and (2) it was assumed that four people were in each car rather than the three or fewer that State-Bureau studies now show to be typical for pleasure travel.

makes it difficult to meaningfully compare them with the costs of the program. The following generalizations can be made about these benefits:

- Highway users will experience substantial benefits from highway beautification in increased comfort, convenience, pleasure, and safety.
- The highway beautification program is a part of and is fostering the general interest in a higher quality of living now so apparent in this country.
- Highway beautification will generate economic activity because of the spending for such beautification measures as nursery products and informational signs, and the enhanced opportunities for economic growth in areas made attractive for tourists or other consumers.
- The economic life of a highway can be prolonged by scenic enhancement. The enduring values associated with parkways now several decades old, demonstrate the wisdom of surrounding highways with landscaping that will endure rather than with manmade structures that may soon become obsolete.
- Outdoor advertising controls should result in fewer but more attractive and profitable signs.
- Outdoor advertising controls may reduce advertising costs—as, for example, by roadside businesses now using outdoor advertising only because their competitors do.
- Junkyard screening should benefit junkyard operators by providing an improved public image.
- Some landowners will benefit through higher land values.
- Official information centers and right-of-way signs have benefited motorists, roadside businesses, and local communities.
- The need to provide advertising services at information centers offers significant economic opportunities for outdoor advertising companies.
- In addition to the benefits of highway beautification, there are costs from not beautifying highways. These include roadside blight and all the problems of blight—highways that become obsolete prematurely, highways that are unsafe and confusing for motorists, and increasing handicaps in competing for tourist trade in the world market.

When these benefits expected from highway beautification are considered along with the costs and disadvantages, decisionmakers may be aided in determining the future of the program.

### *Studies of the Economic Impact of the Highway Beautification Act of 1965—Listed by State*

**Alabama**

*Capital Income Effects of Signboard Regulation, Control, and Removal on Selected Kinds of Businesses and Land Segments Located on Interstate and Primary Highway Systems in Alabama*, University of Alabama.

**California**

*Impact and Implications of Highway Beautification Act of 1965 on Motels in the City of Chico, California*, California Division of Highways.

**Connecticut**

*Environmental Appearance as a Factor in Highway Design*, Yale University.

**Georgia**

*A Study to Examine Some Critcial Areas in Aesthetics and Economics as These Topics Relate to Land and Land-Based Structures*, Georgia State College.

**Indiana**

*A Study of Some Effects of Junkyard Screening and Billboard Density*, Purdue University.

**Kentucky**

*Economic Impacts of Highway Beautification Act in Kentucky*, Spindletop Research Center.

**Maine and New Hampshire**

*Highway Beautification Study—Maine and New Hampshire*, Wilbur Smith and Associates.

**Missouri**

*Estimates of the Impact of Sign and Billboard Removal Under the Highway Beautification Act of 1965*, University of Missouri.

**Nebraska**

*Economic Impact of Highway Beautification (Economic and Legal Problems Related to Roadside Beautification and Recreational Development Along Nebraska Interstate 80)*, University of Nebraska.

**New Jersey**

*Identification and Estimation of Economic Benefits from Scenic Enhancement of New Jersey Highways*, Rutgers University.

**New Mexico**

*The Effect of Highway Billboard Advertising Upon Selected Southern New Mexico Motels and Their Guests*, New Mexico State University.

**New York**

*A Study To Investigate the Impact on the Outdoor Advertising Industry in Reaction to the Highway Beautification Act of 1965*, Rennselaer Polytechnic Institute.

**Ohio**

*Comprehensive Evaluation of Highway Sign and Billboard Regulations*, University of Akron.

**Pennsylvania**

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**Tennessee**

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*Methods Used by Tennessee Motorists to Select and Locate Lodging and Automotive Services*, Memphis State University.

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*Economic Effects of the Highway Beautification Program*, Texas A&M University.

**Washington**

*Impact of the Highway Beautification Act on Outdoor Advertising Firms in Washington State*, University of Washington.

*Peripheral Land Study: Economics, Esthetics, and Highways*, University of Washington.

*Factors Influencing Patrons to Stop at Selected Types of Motels*, University of Washington.

**West Virginia**

*The Impact of Highway Beautification on the Outdoor Advertising Industry in West Virginia*, West Virginia University.

**Wyoming**

*Attitudes of Highway Oriented Businesses in Southern Wyoming Toward Highway Billboard Advertising*, University of Wyoming.

*Traveler Attitudes Toward Highway Billboard Advertising: A Survey of Selected Wyoming Motel Patrons*, University of Wyoming.

**Nationwide**

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(3) *Highway Scenic Beauty Doesn't Jus Happen*, by Wilbur J. Garmhausen, Publi Works, vol. 97, No. 9, September 1966, p. 124

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*(Continued on p. 17)*

# Highway Interchange Locations for Churches—A Pilot Study in Washington, D.C.

*BY THE OFFICE OF RESEARCH AND DEVELOPMENT BUREAU OF PUBLIC ROADS*

**Reported by MARTIN M. STEIN, JOHN YASNOWSKY, JR., and FLOYD I. THIEL,[1] Economists, and MICHAEL R. HORWITZ, Sociologist, Economics and Requirements Division**

***The optimal use of the highly valued land in the vicinity of highway interchanges has been a subject for research and discussion for many years. The pilot study described in this article sought to provide some insight into whether churches and similar social institutions are among those land uses that can profit from an interchange location and in turn contribute to the efficient and orderly development of the interchange area. The scope of the pilot study was limited to learning the attitudes toward interchanges of church spokesmen in the Washington metropolitan area and to determining the extent and nature of previous relevant research. Information was obtained by conducting a literature search, by interviewing spokesmen for 35 of the 36 churches located at interchanges along the Capital Beltway, I–495, and by interviewing several church location planners who are responsible for selecting suitable sites for future church buildings.***

***From the findings of the study it is suggested that churches often can benefit from interchange locations. This results partly because modern churches are largely automobile oriented, and accessibility to the motorist is important. Interchange areas might be more appropriate for churches in which the members reside some distance away than for those churches in which the members reside in the immediate neighborhood. Church location planners generally favored sites near interchanges because of two important interchange characteristics—visibility and accessibility. Those planners who did not favor interchange locations felt that land costs were too high or that it was more important to be located in the center of a residential neighborhood.***

***Regardless of the opinions expressed by pastors and church-location planners, one fact was evident: more interchanges on the Capital Beltway, I–495, contain a church, than a filling station, a restaurant, a motel, a shopping center, or a school.***

## *Introduction*

THE ACTIVITIES that are to be located near highway interchanges must be determined carefully. Some activities can benefit from being near a highway interchange, and, at the same time, be beneficial to the interchange area; other activities cannot gain sufficiently to justify paying the high land costs often associated with interchange locations. Certain types of activities may even be impaired if they are located near an interchange or may be harmful to the interchange.

Progress has been made in ascertaining land uses that are suitable for interchange areas and in determining those that are compatible with one another near interchanges. Establishments providing highway services, for example, have an important role at many interchange locations. Other commercial and industrial activities also appear appropriate in many interchange areas, as do residential activities and others, provided adequate precautions are taken to assure compatiblity between them and the interchange.

In studies of interchange development, and in practice, some attention has been given to the suitability of interchange areas for churches (and schools). Around the Capital Beltway in Washington, D.C., for example, 36 churches have been counted within a half mile of 21 of the 36 interchanges. To learn more about the suitability of interchange locations for churches, a pilot study, described in this article, was conducted in August 1967.

## *Scope of Study and Methods Used*

In the pilot study, data from several sources were used. From a windshield survey of general land uses along the Capital Beltway, I–495, the number and location of churches were determined. The churches included in the survey are listed in table 1 and their locations are shown in figure 1. Telephone and personal contact with spokesmen for these churches and with 10 church location planners provided primary information for the study. In addition, information was obtained from a number of secondary sources, which are listed in the bibliography (*1*)–(*35*).[2] Although information was gathered from all the churches located within a half mile of the beltway interchanges, it is quite generalized—much less comprehensive than would be needed for a case study, for example. The time and resources available usually permitted only one unstructured interview with a spokesman from each church in the study group.

The extent to which respondents may have reflected all views of their congregations, or even a consensus, is not known. Although interviews were sought with the pastors of the churches, other well-informed representatives sometimes provided information in the pastor's absence. Even so, it is possible that these spokesmen were not aware of all the opinions that the church members might have concerning the suitability of interchange areas for church locations. Highway noise during church services, for example, might seem less of a problem to a pastor with an active role in the service than to a member of the congregation who is primarily a listener.

## *Trends in Church Membership*

An increasing number of American people have become affiliated with religious institutions. Church membership increased from 47 percent of the U.S. population in 1930, to 57 percent in 1950, and to 64 percent in 1963,

[1] Floyd I. Thiel is the leader of the Economics Task Group, which focuses on the study of the economic effects of highway investment. The objective of this research group is to define the essential factors that stimulate economic activity and change land-use functions adjacent to new highway facilities.

[2] Italic numbers in parentheses indicate references listed in bibliography on page 16.

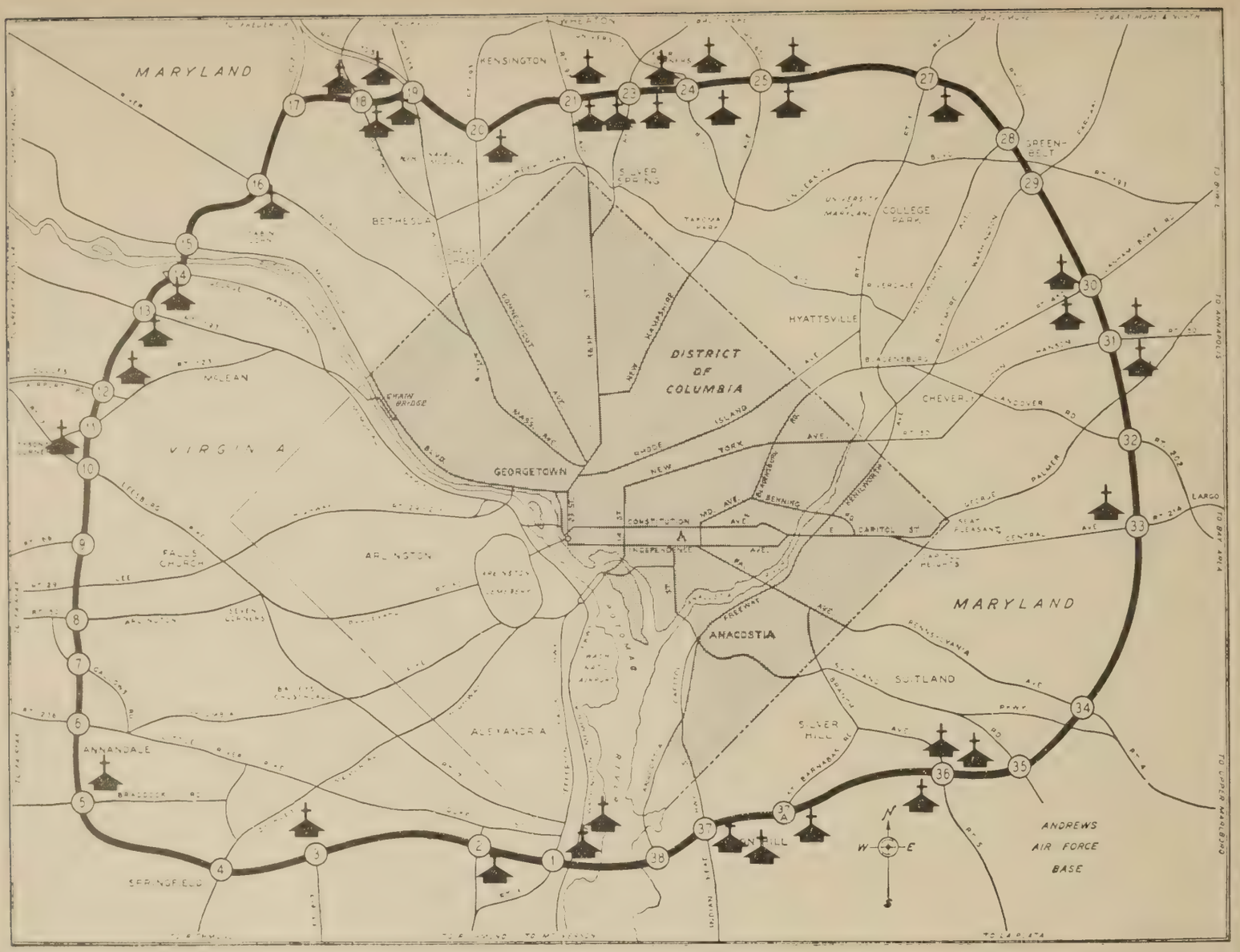


*Figure 1.—Locations of 36 churches near interchanges of the Capital Beltway, I-495, surrounding Washington, D.C.*

as shown in figure 2. The number of churches has also been increasing at a faster rate than U.S. population, though not as fast as church membership. The trends in the growth of churches and of church membership from 1940 to 1963 are shown in figure 3. The slower growth in the number of churches apparently reflects the tendency for individual church units to serve more members as time goes by. Yet the construction of religious buildings is big business, over $1 billion a year (*1*), and careful planning of this investment is justified.

In the Washington metropolitan area, a similar growth in church membership and in the number of churches is reflected. During the 1950–60 period, Protestant church membership increased nearly 60 percent and the number of Protestant churches increased 40 percent, while population in the Washington metropolitan area increased only 35 percent. From 1960 to 1965, however, the population grew at a more rapid rate than the number of Protestant churches, as shown in figure 4. This trend like the trend illustrated in figure 3 also shows a tendency for churches to serve more members. The information included here on membership and number of churches is confined to the churches associated with the Council of Churches of greater Washington, D.C., which represent approximately 25 percent of the total church membership and 33 percent of the total number of churches in the Washington metropolitan area.

When the Washington metropolitan area is considered by political subdivisions, certain variations are found among the churches studied. From the period 1960–65, the District of Columbia experienced not only a loss in the number of churches but even more of a loss in the number of church members. The Maryland and Virginia suburbs, on the other hand, experienced an increase both in church membership and in the number of churches, as shown in figure 5. These variations may be due to different population growth rates—District of Columbia population is growing at a slower rate—and to the fact that no data are available for some denominations such as the African Methodist Episcopal, and African Methodist Episcopal Zion.

### *Criteria for Church Site Selection*

Insight into the suitability of interchange areas for church activities can be gained by considering some of the criteria for church location and determining whether they are satisfied by interchange areas. Several of the criteria for church sites that seem to be generally satisfied in interchange areas are visual prominence, vehicle accessibility, and easily identified address. Other criteria which interchange areas generally fail to satisfy include pedestrian accessibility—perhaps becoming less important—site location near the center of the membership or neighborhood and site location removed from the area of high land values. Interchange areas seem no better or worse than other areas in meeting some of the requirements for church sites which include: (1) Adequate parking facilities (2) proximity to a shopping center (3) suitable zoning, and (4) a suitable lot, considering esthetics, utilities, size, shape, and slope.

The relative importance of the various location characteristics or criteria depends largely

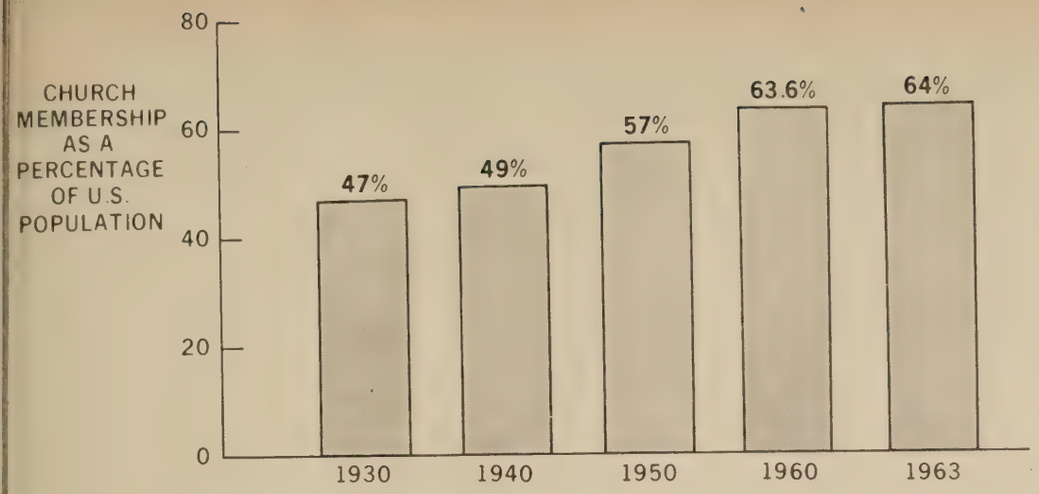


*Figure 2.—Church membership as a percentage of U.S. population, 1930–63.*

on the type of church. A church that draws membership from a wide area will emphasize vehicle accessibility, parking facilities, and visual prominence, whereas a neighborhood church that draws membership from a local area has, in the past, favored locations with easy access for pedestrians.

The different factors to be considered in selecting a church location often complement each other. For example, a church near a shopping center or a school may be able to benefit from good accessibility and the abundant parking typical at shopping centers and schools. Even the terrain can complement the location. Level slopes, lower construction costs, and high land provides visual prominence and, possibly, improved drainage.

On the other hand, the characteristics of a location may be conflicting. For example, good accessibility means being close to heavily traveled routes where noise and other traffic disturbances may be inherent. The same is true of the proximity of shopping centers, particularly for evening activities during the week. Visual prominence may result in higher construction cost, and close proximity to a residential area may conflict with local zoning requirements.

### *Experience of Church Location Planners in Washington, D.C.*

Church location planners, primarily clergymen with training in planning, architecture, and administration, were interviewed during the pilot study. These specialists, who are responsible for recommending or selecting suitable sites for future church buildings, have the experience necessary to evaluate interchange locations as possible church sites. Their opinions varied as to the desirability of locating a church building near a highway interchange. The majority agreed that the visibility and accessibility afforded by an interchange site were important considerations. One planner illustrated his view of the importance of church visibility by stating, "Where a sign is located to direct motorists to the church, this is where the church should be." However, a few took the position that visual prominence could be obtained equally as well at sites away from the interchange. Some also contended that an interchange location was not nearly as accessible as a site in the center of a residential neighborhood. They pointed out that interchanges may divide the residential development into four quadrants so that a church located near the interchange facility may be on the outer edge of its actual and potential membership rather than in the center.

The generally high cost of land was one of the reasons given as to why interchange sites are not always considered the most desirable for churches. Land costs were considered by nearly all of the planners to be an important factor in site selection; consequently, planners seek to recommend locations before new development causes land prices to rise—long before actual church construction begins.

At the outset of this pilot study it was hypothesized that interchange locations might not be suitable as church sites because of the noise, fumes, and other undesirable characteristics often associated with heavy traffic. However, the discussions with the church planners indicated that traffic noise and fumes ordinarily are not troublesome, because most of the new church buildings are air-conditioned and outside interferences become less of a problem. Church activities that are conducted out-of-doors are generally held at the rear of the building where there is some protection from highway noise and fumes.

Although most of the church location planners preferred quiet residential areas for church sites, some favored sites in commercial areas along major highways or near interchanges. In addition to being visible to a larger number of passing motorists, a commercial area permits the joint use of parking

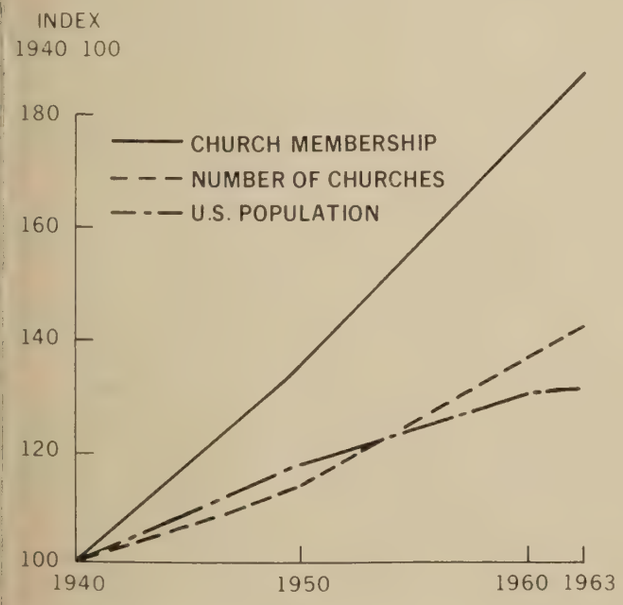


*Figure 3.—National trends in church and church-membership growth 1940–63.*

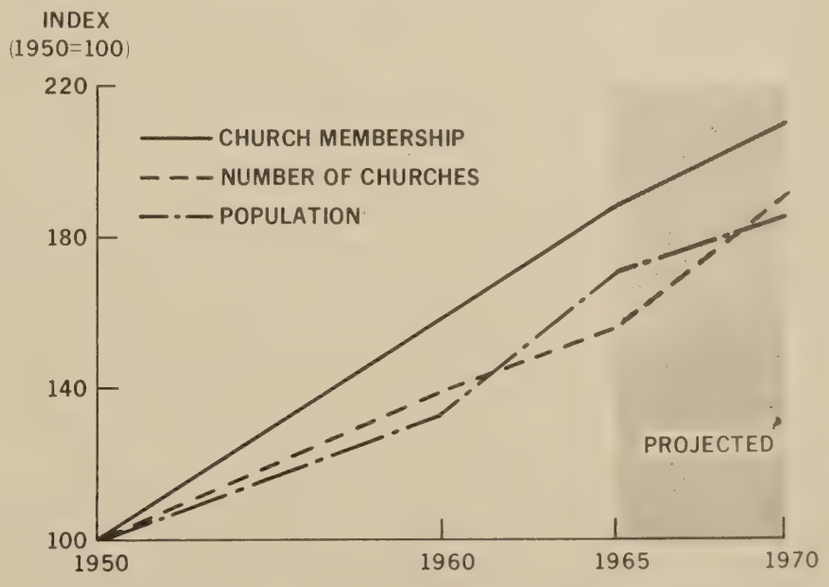


*Figure 4.—Washington area Protestant churches, Protestant church members and population, 1950–70.*

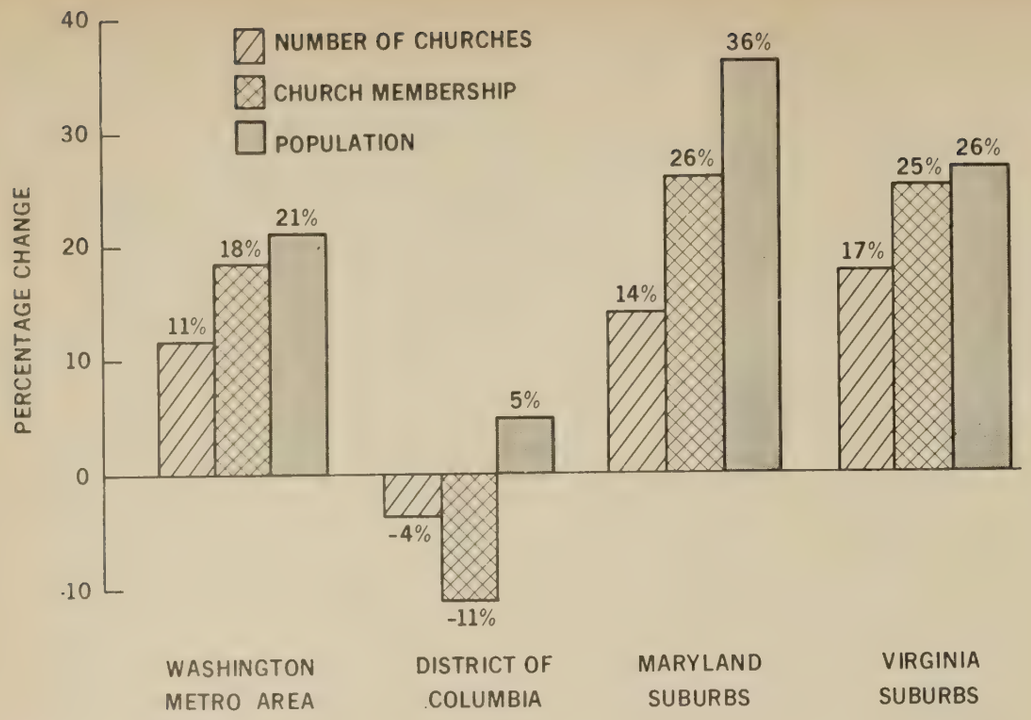


*Figure 5.—Changes in Protestant churches and church membership, Washington metropolitan area, 1960–65.*

Several planners spoke of a planning concept in which churches and similar institutions are used as buffers between the commercial developments at interchange facilities and the residential developments farther back. Such an arrangement, of course, would provide some of the benefits of both residential and commercial locations. Also, if several churches were grouped in this fashion, they might be able to realize some economies through the use of their combined facilities.

The consensus of the planners was that churches are becoming larger, that fewer members are walking to church, and that members are driving longer distances, partly because of improved highway transportation. However, the planners felt that highways were not an influence in increasing membership even though the highways sometimes allow a church to retain its members after they have moved to other neighborhoods.

### *Churches on the Capital Beltway*

There are 36 churches within a half mile of the interchanges of the Capital Beltway, I–495. Information was gathered from only 35 of the churches, as several attempts to contact one store-front church in Virginia were unsuccessful. Most of the 36 churches were located there before the beltway was constructed. In fact, only six churches have been located at beltway interchanges since it opened in 1964. Seven other churches were constructed in the early 1960's when only general information was available about the facilities owned by the commercial establishments. Nearly all the church location specialists agreed that consideration should be given to a site that permits Sunday parking on facilities used for other purposes during the week.

**Table 1.—Churches located within half mile of interchanges of Capital Beltway, I–495** [1]

| Name of church | Interchange number | Feeder road |
|---|---|---|
| Abundant Life—Independent | 1 | U.S. 1. |
| St. Mary's Roman Catholic | 1 | U.S. 1. |
| Church of God of Prophecy—Independent | 2 | Va. 241. |
| United Pentecostal | 3 | Va. 613. |
| Ravensworth Baptist | 5 | Va. 650. |
| Providence Baptist | 10 | Va. 7. |
| Latter Day Saints | 12 | Dulles Airport Road. |
| St. Luke's Roman Catholic | 13 | Va. 193. |
| McLean Bible | 13 | Va. 193. |
| Concord Methodist | 16 | Md. 190. |
| St. Jane Frances de Chantal Roman Catholic | 18 | Md. 187. |
| North Bethesda Methodist | 18 | Md. 187. |
| St. Luke's Episcopal | 18 | Md. 187. |
| Temple Hill Baptist | 19 | U.S. 240. |
| North Chevy Chase Christian | 20 | Md. 193. |
| Calvary Lutheran | 21 | Md. 97. |
| Montgomery Hills Baptist | 21 | Md. 97. |
| Christ Congregational | 23 | U.S. 29. |
| Marvin Memorial Methodist | 23 | U.S. 29. |
| Knox Presbyterian | 23 | U.S. 29. |
| Temple Israel | 24 | Md. 193. |
| St. Bernadette's Roman Catholic | 24 | Md. 193. |
| Good Sheperd Methodist | 25 | Md. 650. |
| Our Savior Episcopal | 25 | Md. 650. |
| North College Park Pilgrim | 27 | U.S. 1. |
| First Baptist of Carrolton | 30 | Md. 450. |
| St. Christopher's Episcopal | 30 | Md. 450. |
| Grace Presbyterian | 30 | Md. 450. |
| Ebenezer Methodist | 31 | U.S. 50. |
| Ridgely Methodist | 33 | Md. 214. |
| Church of the Nativity-Episcopal | 36 | Md. 5. |
| Church of St. Phillip the Apostle—Roman Catholic | 36 | Md. 5. |
| Latter Day Saints | 36 | Md. 5. |
| Henson Valley Christian | 37 | Md. 210. |
| Forest Heights Baptist | 37 | Md. 210. |
| St. Ignatius' Roman Catholic | 37A | Md. 414. |

[1] Survey made in 1967.

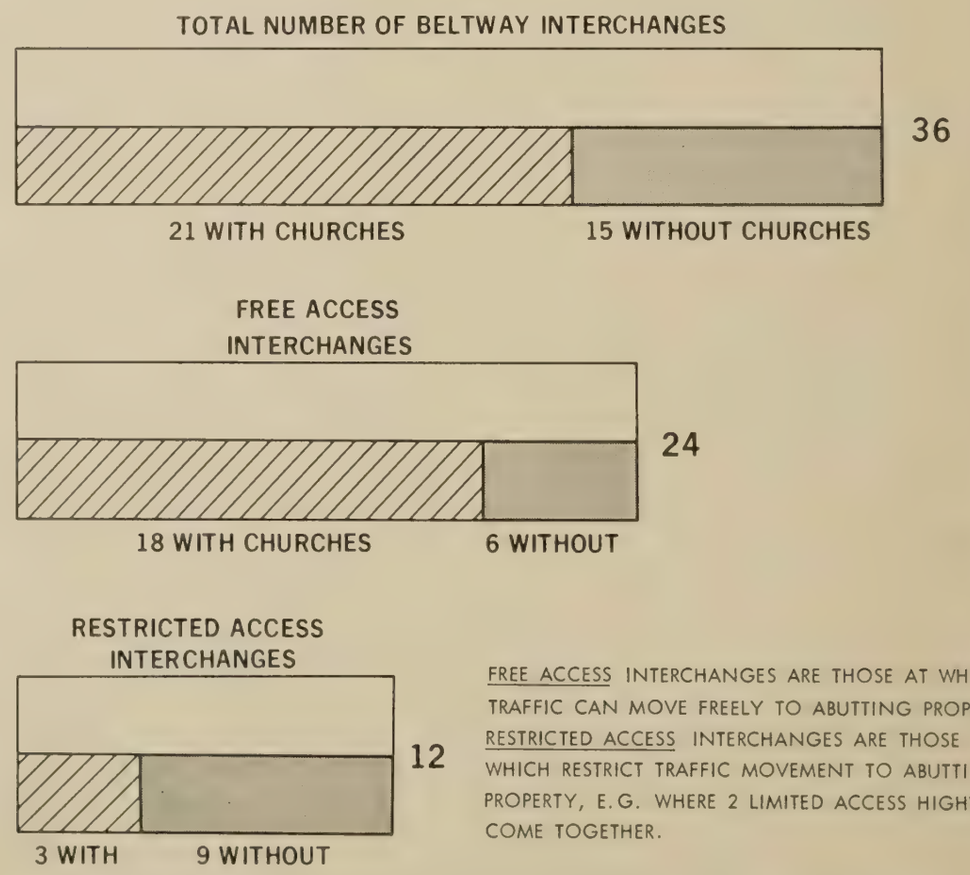
TOTAL NUMBER OF BELTWAY INTERCHANGES
36
21 WITH CHURCHES
15 WITHOUT CHURCHES
FREE ACCESS INTERCHANGES
24
18 WITH CHURCHES
6 WITHOUT
RESTRICTED ACCESS INTERCHANGES
12
3 WITH
9 WITHOUT
FREE ACCESS INTERCHANGES ARE THOSE AT WHICH TRAFFIC CAN MOVE FREELY TO ABUTTING PROPERTY.
RESTRICTED ACCESS INTERCHANGES ARE THOSE WHICH RESTRICT TRAFFIC MOVEMENT TO ABUTTING PROPERTY, E.G. WHERE 2 LIMITED ACCESS HIGHWAYS COME TOGETHER.

*Figure 6.—Church locations by type of interchange, Capital Beltway, I–495.*

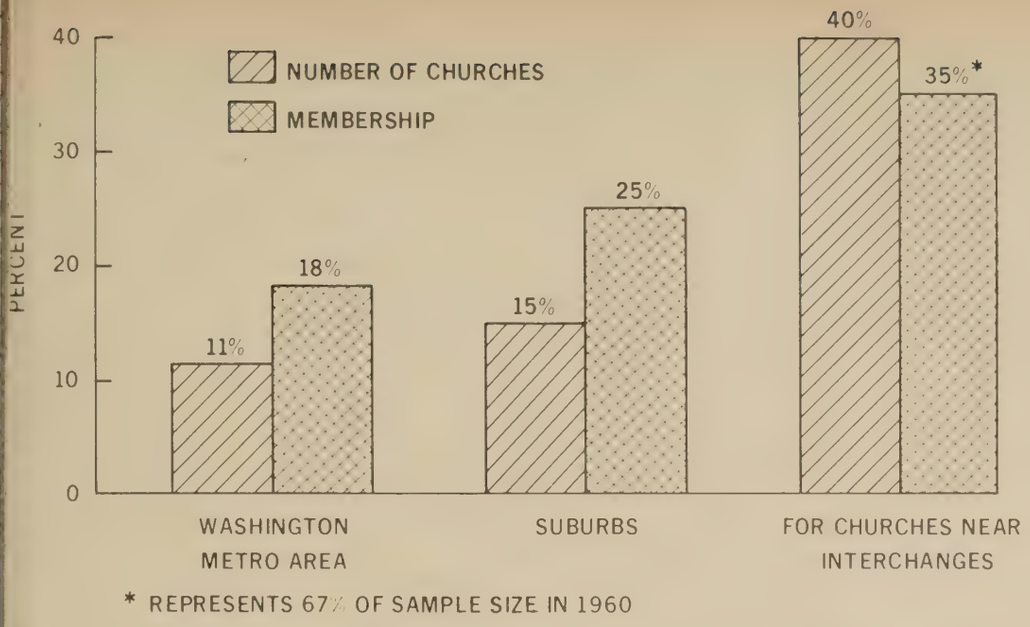


*Figure 7.—Changes in Protestant churches and church membership, Washington metropolitan area, suburbs, and interchange areas, 1960–65.*

beltway location. The dates that original church buildings were constructed within a half mile of highway interchanges are shown in table 2. Related highway events, such as the beltway opening, are also listed in the table. The number of new churches at highway interchanges varies between zero and three each year. Information about the general location of the beltway was available for some time before the actual opening in 1964. In Virginia, for example, six of the eight churches surveyed were constructed after acquisition for the beltway right-of-way began in January 1958, and five were constructed after December 1961, when portions of the Capital Beltway were opened to traffic.

The 36 churches are located at 21 of the 36 beltway interchanges, as stated previously. Of the 24 *free access* interchanges—where traffic can move freely to abutting property by leaving the beltway at the interchange—18 have one or more churches. Of the 12 *restricted access* interchanges—where traffic can move from one highway to another but where movement from the beltway to abutting property is restricted—only three have churches located within a half mile. Thus, as shown in figure 6, three-fourths of the *free access* interchanges have churches nearby.

## *Experience of Churches Near Beltway Interchanges*

The information obtained about the churches near the interchanges of the Capital Beltway was limited and incomplete; yet some of it might provide an insight into the suitability of interchange locations for churches. Membership trends, for example, as well as church improvements, may be affected by a good or a poor highway location.

Churches near the beltway interchange are experiencing noticeable increases both in the number of churches and in the number of church members. Because of the absence of an appropriate group of churches that could be used for comparison, the influence of beltway interchanges on this growth cannot be established conclusively; but compared with changes in the Washington metropolitan area and in the Maryland and Virginia suburbs, churches near Beltway interchanges, during the past 5 years, have experienced the changes shown in table 3. This information was derived from records compiled by the Council of Churches of Greater Washington. The information covers most of the Protestant churches in the Washington area; much of the same information is depicted graphically in figure 7.

Spokesmen for the 35 churches surveyed generally believe that the Capital Beltway has no adverse effect on the activities of their churches. Whereas 10 of the 35 respondents admitted there was some traffic noise, 25 reported that there was no noise or at least that noise was no problem. These overall opinions of the beltway's effect on church activities are listed in table 4. As shown for the 35 churches, 12 spokesmen reported that the beltway had no effect, 21 reported a favorable effect, and 2 reported the effect to be unfavorable.

It is understandable why church spokesmen gave varied reports on the suitability of interchange locations for churches. Churches have varying needs for such highway interchange characteristics as visibility and accessibility. Some churches serve an entire community or region and are sometimes regarded—and regard themselves—as communitywide or regional churches. Other churches, regarded more as neighborhood churches, have their members predominantly in the neighborhood or in a portion of a large community. Whether a church should be regarded primarily as a neighborhood church or a church serving a large area such as a community, depends generally on how widely the membership is diffused, that is, how far members typically travel to church.

For the simple analysis described here, churches were classified generally as community churches—(1) if approximately 25 percent or more of the members travel to church by the beltway, and/or (2) if the associated denomination or brotherhood accounts for about 2 percent or less of the congregations in the Washington area. The classification is based on a preliminary analysis in which it was determined that about 2 percent may be a breaking point between those groups with approximately 25 percent or more of the members using the beltway for church travel. Applying these

**Table 2.—Churches constructed in interchange areas of Capital Beltway, I–495, during different phases of highway construction**

| Phase of highway construction | Year | Churches within half mile of interchanges |
|---|---|---|
| | | *Number* |
| Right-of-way acquisition started | Before 1958 | 17 |
| | 1958 | 2 |
| | 1959 | 2 |
| Beltway partially open | 1960 | 0 |
| | 1961 | 2 |
| | 1962 | 3 |
| | 1963 | 2 |
| Beltway opening | 1964 | 1 |
| | 1965 | 3 |
| | 1966 | 2 |
| | 1967 | 1 |
| Total | | [1] 35 |

[1] Information from one of the 36 churches could not be obtained.

**Table 3.—Changes in number of churches and church members in different sections of Washington metropolitan area, 1960–65**

| Location | Change in number of churches | Change in number of members |
|---|---|---|
| | *Percent* | *Percent* |
| Near beltway interchanges | +40 | +35 |
| Maryland and Virginia suburbs | +15 | +25 |
| Washington metropolitan area | +11 | +18 |
| District of Columbia | −4 | −11 |

**Table 4.—Effect of Capital Beltway on activities of 35 churches, according to church spokesmen**

| Beltway effect | Opinions of church spokesmen |
|---|---|
| | *Number* |
| None | 12 |
| Very favorable | 10 |
| Favorable | 6 |
| Slightly favorable | 5 |
| Slightly unfavorable | 2 |
| Unfavorable | 0 |
| Very unfavorable | 0 |

criteria to the Washington metropolitan area resulted in classifying most Catholic, Methodist, and Baptist groups as neighborhood churches and Latter Day Saints, Pentecostal, and Pilgrim congregations as communitywide or regional churches. There are obviously exceptions. For example, two Methodist churches and one Lutheran church in interchange areas seem to be community churches and some of the Latter Day Saints churches are acquiring characteristics of neighborhood churches. The history of a particular congregation and how the church regards itself are considered a part of the criteria. Figure 8 and tables 5 and 6 provide additional information on the denominations of beltway interchange churches and on the classification of community and neighborhood churches.

Of the 35 churches surveyed, 12 can be regarded as community or regional churches and 24 as neighborhood churches. Spokesmen for the 12 community churches apparently had a higher opinion of the beltway's usefulness than spokesmen for the 23 neighborhood churches. The differences in the opinions expressed by church spokesmen concerning beltway effects on church activities are listed in table 7.

Highway interchange areas can apparently meet the site needs of some but not all churches. This fact is based on the experience cited by representatives of the 35 churches surveyed, on the comments of selected church planners, and on selected literature pertaining to church planning. Table 8 lists some of the site requirements of neighborhood and community churches and refers to the apparent ability of interchange areas to meet these needs. As can be seen, interchange areas appear to be more suitable for community-wide or regional churches than for neighborhood churches.

**Table 5.—Denominations of community and neighborhood churches at interchanges of Capital Beltway, I-495**

| Denomination | Number of churches at interchanges | Number classified as community churches[1] | Number classified as neighborhood churches |
|---|---|---|---|
| Roman Catholic | 6 | 0 | 6 |
| Methodist | 6 | 2 | 4 |
| Baptist | 6 | 0 | 6 |
| Episcopal | 4 | 1 | 3 |
| Independent | 3 | 2 | 1 |
| Mormon | 2 | 2 | 0 |
| Presbyterian | 2 | 1 | 1 |
| Disciples of Christ | 2 | 0 | 2 |
| Hebrew | 1 | 1 | 0 |
| Lutheran | 1 | 1 | 0 |
| Pilgrim | 1 | 1 | 0 |
| Pentecostal | 1 | 1 | 0 |
| United Church of Christ | 1 | 0 | 1 |
| Total | 36 | 12 | 24 |

[1] Churches were classified as community churches if (1) approximately 25 percent of the members travel to church via the beltway, and/or (2) the denomination or brotherhood accounts for about 2 percent or less of the congregations in the Washington area. The history of a particular congregation and whether it considers itself a community or neighborhood church were also considered in the classification.

**Table 6.—Relation of denominations to beltway-interchange churches and to Washington area churches**

| Denomination | Percent of churches near Capital Beltway [1] | Percent of all churches in Washington area |
|---|---|---|
| | *Percent* | *Percent* |
| Catholic | 17 | 9 |
| Methodist | 17 | 15 |
| Baptist | 17 | 11 |
| Episcopal | 11 | 9 |
| Independent | 8 | 20 |
| Mormon | 6 | 1 |
| Disciples of Christ | 6 | 2 |
| Presbyterian | 6 | 7 |
| United Church of Christ | 3 | 2 |
| Pilgrim | 3 | 0.4 |
| Pentecostal | 3 | 0.1 |
| Lutheran | 3 | 6 |
| Hebrew | 3 | 1 |

[1] Percentages have been rounded and do not total 100 percent.

**Table 7.—Effect of Capital Beltway on church activities, according to church spokesmen**

| Beltway effect | Opinions of community church spokesmen [1] | Opinions of neighborhood church spokesmen |
|---|---|---|
| | *Number* | *Number* |
| Favorable | 12 | 9 |
| Unfavorable | 0 | 2 |
| None | 0 | 12 |
| Total | 12 | 23 |

[1] Churches were classified as community churches if (1) approximately 25 percent of the members travel to church via the beltway, and/or (2) the denomination or brotherhood accounts for about 2 percent or less of the congregations in the Washington area. The history of a particular congregation and whether it considers itself a community or neighborhood church were also considered in the classification.

**Table 8.—Apparent capability of interchange areas to meet needs of church sites**

| Church site needs | Extent to which suburban interchange areas serve church site needs |
|---|---|
| Neighborhood church: | |
| Visual prominence | Good. |
| Vehicle accessibility (local) | Fair. |
| Adequate parking | Undetermined. |
| Out of high value area | Poor. |
| Near community center | Poor. |
| Pedestrian accessibility | Poor. |
| Community church: [1] | |
| Visual prominence | Good. |
| Vehicle accessibility (all traffic) | Good. |
| Adequate parking | Undetermined. |
| Easily identified location | Good. |

[1] Churches were classified as community churches if (1) approximately 25 percent of the members travel to church via the beltway, and/or (2) the denomination or brotherhood accounts for about 2 percent or less of the congregations in the Washington area. The history of a particular congregation and whether it considers itself a community or neighborhood church were also considered in the classification.

## *Experiences of Individual Churches*

Like other activities near interchange areas, churches often have been able to use inter-

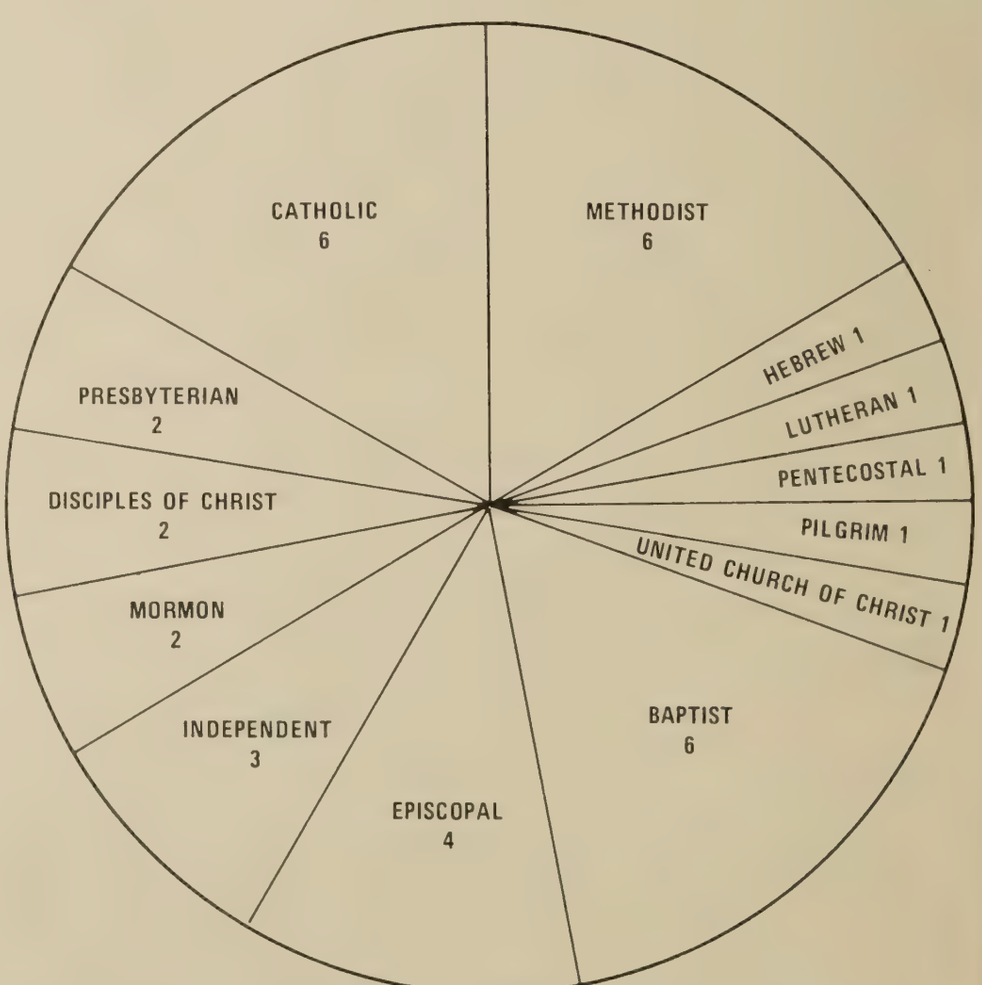


*Figure 8.—Denominations of churches at interchanges of Capital Beltway, I-495.*

*Figure 9.—Mormon church as seen from Capital Beltway, I-495.*

*Figure 10.—Ebenezer Methodist Church at intersection of I-495 and U.S.-50.*

change opportunities to good advantage. "Only minutes away by the Beltway" and "Exit 30, Capital Beltway" are typical notices that churches use to indicate how quickly and easily they can be found. Church spokesmen emphasize the advantages of interchange accessibility in many ways, such as for areawide meetings and for members who wish to continue in the same congregation after a change of residence. Visibility is also used to good advantage by several churches that do not have easy access. Example of churches visible from the Capital Beltway are shown in figures 9 and 10.

Churches need to be accessible to members, but need not necessarily be near the geographic centers of the members' residential areas. Churches, like shopping centers, can expect to attract fewer trips from the *inboard* or central business district side of a metropolitan area than from the *outboard* side (*2*). To learn more about this *inboard-outboard* effect on a church and how the beltway may change it, a rudimentary analysis was performed using a listing of members' residences for the Christ Congregational Church, Silver Spring, Md., the interchange church shown in figure 11. It appears that fewer members may in fact reside on the *inboard* or central business district side of the church than on the so-called *outboard* side, unless a disproportionately high number of local members reside in the *inboard* side. About 4 percent of the members reside in the area approximated by the quadrant to the *inboard* or south side of the local area of the church; about 20 percent reside in the quadrant on the *outboard* or north side of the *local* area. The *local* area is defined here as that portion of Silver Spring, Md., encompassed by the postal-zip-code area in which the church is located. This area extends out from the church an average of about 2 miles and contains about 44 percent of the residences of the members, as shown in figure 12.

Any beltway effects being experienced by the Christ Congregational Church are apparently minor. Only about 15 percent of the church members arrive via the beltway, yet a church spokesman described the effect of the beltway on church activities as very favorable. This congregation, with a building constructed in 1949, is now planning an expansion. The membership is increasing and apparently coming from farther away. Before the beltway opened, members residing outside the *local* area constituted slightly more than 52 percent of the total congregation. Now, about 56 percent of the new members reside outside the *local* area. The increase seems to be coming predominantly from quadrants to the west and north of the local area. As shown in figure 12, the quadrant to the west of the *local* area formerly contained about 26 percent of the members; now about 27 percent of the new members reside in this area through which the beltway was built. The small portion of members being attracted from the east—1.9 percent before 1954, and 2.6 percent since—might be explained in part by the presence of another Congregational Church there.

## *Summary*

The pilot study reported here has achieved at least some success: It has produced enough information to suggest strongly that church activities at interchange areas may, indeed, be an appropriate land use. The belief that churches near highway interchanges might suffer from noise, fumes, or other highway disturbances—one of the reasons for undertaking the pilot study—apparently is, at least partly, mistaken. While there are still some who prefer church sites readily accessible to pedestrians (*1*), a number of church location spokesmen apparently now believe—or have become reconciled to the fact—that the role of the pedestrian is becoming less important. In another study of a suburban church, only the pastor walked to church.

Although the study did not disclose as many problems as were anticipated, it obviously has not demonstrated that no problems

*Figure 11.—Christ Congregational Church at intersection of I-495 and U.S.-29.*

are encountered when churches locate near interchange areas, not even in the Washington, D.C., area. More information is needed before definite conclusions can be drawn. For example, it is necessary to show whether churches can, as several spokesmen claim, realize the full potential of high value interchange land. Also, the common assumption that church-generated traffic uses excess capacity at off-peak times may need to be tested because of the trend to use church buildings in the Monday-through-Saturday period. In efforts to analyze and guide interchange area development some attention should probably be given to churches and schools. Also, some of the church-highway matters not dealt with in this paper—the adverse effect churches might have on interchange areas; the location of churches over or above highways to minimize highway barrier effects; church structures over highways or in interchange areas that can be adapted to nonchurch purposes—need at least exploratory research efforts soon. It would also be worthwhile to determine the extent to which church parking space can serve effectively as week day commuter parking as is now taking place in some locations.

## ACKNOWLEDGMENT

The authors wish to acknowledge the contributions of the following persons whose unpublished papers and reports provided background material for the preparation of this article:

Charles A. Ellet, *Church Extension: Planning Goals, Standards, and Methods*, Department of Research and Planning, Council of Churches, National Capital Area, Washington, D.C., 1962.

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The following persons, representatives of churches, were interviewed during the pilot study and have also contributed information on which this paper was based:

Rev. Ralph A. Boyer, regional secretary, Board of American Missions for the Lutheran Church of America.

Rev. Charles A. Ellet, director, Research and Planning Council of Churches of Greater Washington.

Rev. William J. Cumbie, executive secretary, Mount Vernon Association of Southern Baptists.

His Excellency the Most Reverend Edward J. Herman, chancellor of the Archdiocese of Washington.

Rabbi Aryeh L. Gottleib, director, Seaboard Region, United Synagogues of America.

Kermit Scheele, business manager in the Office of the Presbytery of Washington City.

David Simon, church architect, member of American Institute of Architects.

Rev. Chandler M. Smith, executive secretary of the D.C. Convention of Baptists, Washington, D.C.

Reverend J. J. Van Boskirk, executive director, Capital Area Association of the Christian Church, Disciples of Christ.

Reverend Raymond A. Wrenn, executive secretary of the Northern Virginia Board of Missions of the Methodist Church.

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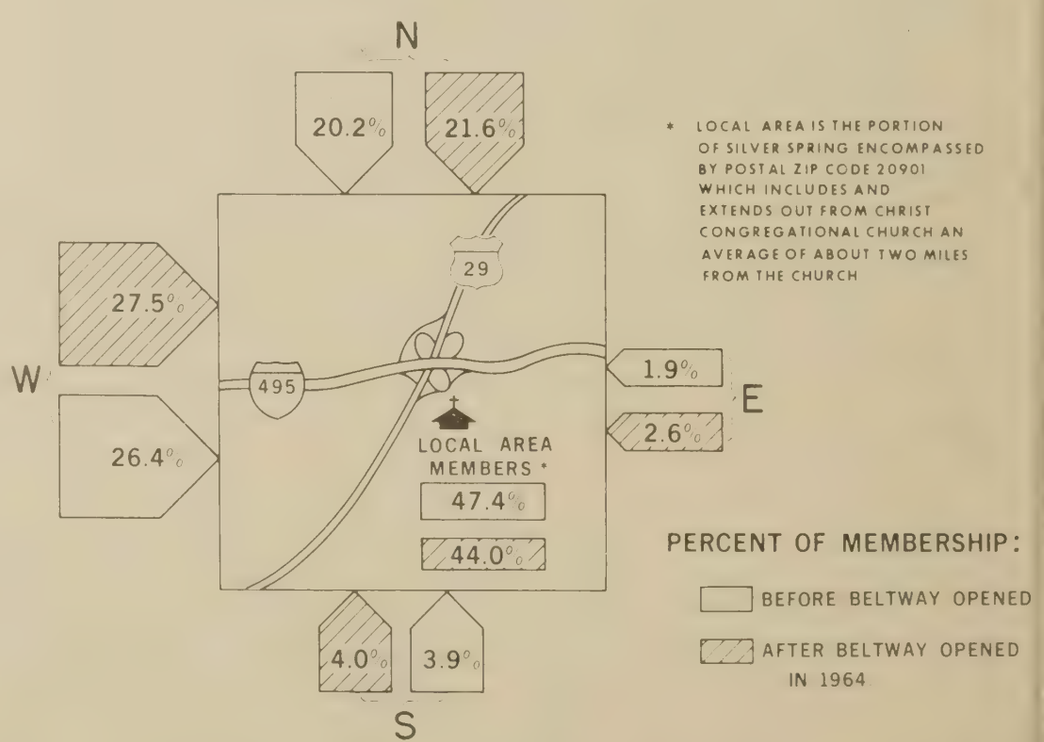


*Figure 12.—Residential locations of members of church at interchange before and after beltway opened.*

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# Parking as an Element Within the Comprehensive Transportation Planning Process

*BY THE*
*OFFICE OF PLANNING*
*BUREAU OF PUBLIC ROADS*

**Reported by LAWRENCE L. SCHULMAN**
**Highway Engineer,**
**Urban Planning Division**

***Parking exerts a qualifying control on the proposal of any future transportation system, and should be included in its proper perspective in the present comprehensive transportation planning process. Cars destined to an area must be parked before the trip purpose can be fulfilled. If demand for parking exceeds available supply, adjustments must be made among the planned roadway system, the planned transit system, and the planned parking program.***

***The author evaluates current status of parking analysis and its relation to the comprehensive transportation planning process, discusses the basic relationships behind drivers choice of parking location, and proposes a new procedure for improving the parking analysis and its coordination within the transportation planning process. Discussed in the new procedures are objectives of a parking analysis, detailed description of the procedure, and use of origin-destination survey data for parking demand.***

***The author details a current parking research project to evaluate some of the possibilities of improving both the coordination of parking within the comprehensive planning process and the general quality of the parking analysis.***

## *Introduction*

UNDER the broad guidelines adopted by the Bureau of Public Roads to foster the development of comprehensive, coordinated, and continuing transportation planning in cities of over 50,000 population, significant improvements have been observed in many phases of the process. In contrast, the parking element has remained an unexplored and often an unrelated item within the transportation planning process. Such an observation is particularly distressing when it is realized that parking considerations can influence the proposals of future transportation systems—that is, parking limitations and regulations can influence the level of congestion resulting from the traffic converging within an area; parking facility location can influence the location of roadways and their volume characteristics; and parking availability can influence the determination of transit levels of service.

The parking philosophy is basically simple. In most urban areas, the majority of travel is generated by automobile, and even though the passengers' actual destinations vary, the termination of the automobile vehicle portion of the trip is always some terminal—either curb space (fig. 1), parking lot (fig. 2), garage (fig. 3), or fringe facility (fig. 4). Therefore, just as future trip destinations within an area must be considered in determining future roadway volumes and capacities, provision of parking facilities must also be considered to allow the logical completion of any trip movement. When situations arise in which demands exceed the physical capacity of the area to provide parking, some program of coordination must be developed among the roadway system, the parking program, and the transit system. It is this type of coordinated program that provides the basis for an adequately designed transportation system.

*Figure 1.—Curb parking represents a major portion of urban parking supply.*

## *Parking Within the Comprehensive Transportation Process*

The conceptual involvement of parking as an element of the transportation planning process is more easily recognized than the methods of introducing it into the process. Should it be a limiting control in the generation of trip ends, a control in the distribution of trip ends, a restraint in traffic assignment, a factor within the modal split, or a combination of all?

Of the several phases in which parking could be introduced, there is one point in the process

*Figure 2.—Parking lots at major new traffic generators frequently use large volumes of urban land.*

*Figure 3.—High urban land costs lead to construction of multistory facilities in many downtown areas.*

*Figure 4.—Fringe parking requires efficient, low cost transit service to ultimate destinations.*

at which adequacy of parking exhibits a controlling condition. That point is immediately after the determination of the zonal auto-driver trip ends. It is at this point that the total number of auto trips destined to each zone is known, and it is at this point that a check should be made to determine whether the zone has the capability of accommodating all the destined trips.

Again, this logic is based on the simple but often forgotten fact that, with few exceptions, every car destined to an area must be parked before the trip purpose can be fulfilled and if the car cannot be parked in an area, it is senseless to design a roadway to bring it there. Therefore, after determining the number of trips that will terminate in a particular area, it must be determined whether the area is able to accommodate all the vehicles requiring parking.

In essence, the parking analysis will involve a process of distributing the demand to the available supply, but the point at which this distribution will enter the phases of the process will depend upon which of the three basic procedures is followed to calculate zonal auto-driver trip ends.

In the first procedure, shown in figure 5, the transit and highway systems are analyzed separately, thereby eliminating the need for a modal-split analysis. This type of analysis would occur in a smaller area where transit plays a minor role in the transportation system. After determining the zonal auto-driver trip ends in the generation phase, they are distributed as parking demand, and the feasibility of accommodating the predicted number of automobiles is evaluated. The results of this evaluation are then analyzed and any obvious inconsistencies are corrected.

In the second procedure, shown in figure 6, the role of transit is considered important, and the two systems—transit and highway—are analyzed together. The trip generation, the trip distribution, and the modal-split phases are all completed before zonal auto-driver trip ends are determined. In this procedure any inconsistencies can be corrected by reevaluating either the trip generation phase, the trip distribution model or the modal-split procedure.

In the third procedure, shown in figure 7, as in the second, the role of transit is considered important. The difference in procedures reflects the arrangement of the internal phases, and in this procedure only the trip generation and the modal-split phases have taken place before the zonal auto-driver trip ends are determined. Here again the auto-driver trip ends are distributed as parking demand, and the resulting parking conditions are examined. If inconsistencies are apparent, then either the modal-split procedures or the trip-generation procedures can be reevaluated.

In each of these procedures, the parking demands have been distributed among the available parking supplies, and any obvious inconsistencies have been assumed to be corrected by changes in one or more of the analytical phases. However, simple changes in municipal policy can cause significant changes

in the parking supply and consequently significant changes in the results of the analysis. Therefore, in each of the evaluations, possible changes in supply must also be considered in addition to adjustments of the analytical phases. Consequently, the analysis must be developed so that changes in total person trips, changes in transit service, or changes in parking supply all can be investigated when an attempt is made to balance the desires to travel to an area and the physical capabilities of the area to receive the trips.

The basic assumption in each of these procedures is that zonal auto-driver trip ends are synonymous with zonal parking demand. It is assumed that each trip end represents the demand for a parking space and that the sum of trip ends together with the parking duration represents the total demand for parking in any zone. It is also assumed that the future forecast of zonal auto-driver trip ends represents the future forecast of zonal parking demands.

### *Suggested Parking Analysis*

As envisioned, the two main objectives of the parking analysis should be: (1) To determine the areas in which parking is deficient and the reasons for the deficiencies and (2) to prevent additional deficiencies by evaluating the realism of future trip-end forecasts in light of existing and future parking supplies as reflected in land use forecasts. One of the preliminary requirements for accomplishing these objectives will be the calibration of a simple computer model capable of: (1) Reproducing the process by which automobiles are distributed among available parking supplies, (2) determining the specific areas of parking deficiency and (3) determining the type of parking—short term or long term—required to eliminate the deficiencies.

The procedure contemplated is a simple distribution model, in which the individual block parking demand is distributed among the supplies available within a composite area. As each potential trip approaches the block of destination, a test is made to determine whether there are any satisfactory spaces available in that block. If space is not available, a search is made to determine the next closest block with available space. As each successive block is explored, a check is made to determine whether the parking space is within acceptable walking distance. This procedure is continued until all the demand is satisfied or all the spaces within acceptable walking distances are exhausted. This simple distribution process is shown in figure 8.

The entire distribution is dependent upon the outlined process; however, the degree of complexity increases as the demand is stratified by parking duration and time of arrival; as supply is stratified by time restriction and cost; and as maximum acceptable walking distances (or composite areas) change with duration, costs, and parking congestion. These stratifications are reflective of theoretical considerations discussed later, and should allow a realistic approximation of the distribution of parked vehicles within the study area.

To facilitate a detailed explanation, the parking analysis can be divided into four phases—data collection, data analysis, model calibration, and final report.

**Data collection**

The data collection phase is of primary importance as it not only supplies information needed to determine and analyze existing parking characteristics of the area, but also the data needed for calibration of the distribution model. The information usually required is the actual location of parking, location of demand, time of arrival, duration of parking, and detailed characteristics of the supply (time restrictions, costs, location, etc.).

There are several possible methods available to collect these data. Probably the best method is the one described under "Current Parking Analysis." Historically, this method has been handled in great detail and the resultant data provides all the information necessary.

Another possible method of accumulating the parking data is to use the information collected during the origin and destination (O–D) data collection survey. Much of the required parking data can be determined directly from the trip cards (trip purpose, demand destination, arrival time, and type of parking), and with few exceptions, the rest can be calculated with little effort; that is, parking duration equals the difference between arrival time of the trip to the central business district (CBD) and the starting time of the trip from the CBD. The only information that is not readily available is the actual location of parking, but this could be obtained by revising standard interview forms to include the question "where did you park your car?" or by conducting a usage study as described under "Current Parking Analysis." The characteristics of the parking supply could be obtained by including a detailed study within the land use data collection procedures.

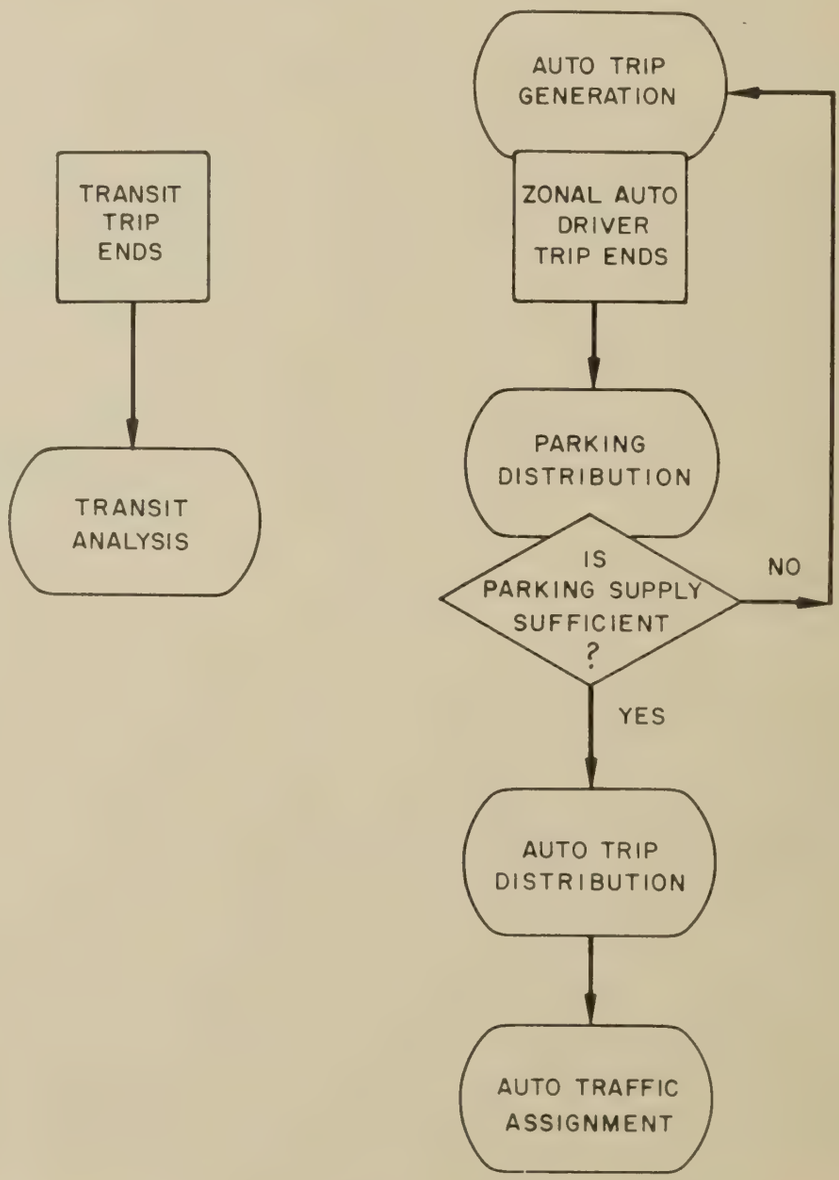


*Figure 5.—Phase sequence of planning process without modal split.*

Although this method of data collection would truly coordinate the parking analysis within the existing transportation process, the method has not been sufficiently explored, and more research is necessary to determine whether the data obtained would be sufficiently accurate for a detailed parking analysis.

Several comments can be made concerning the advantages and disadvantages of using either method. The first disadvantage of O–D data, and probably the greatest objection to its use, is the limited number of observations available for analysis. This limitation is caused by the obvious anomaly of the sample selection. The selection of O–D data is based on the non-CBD end of the trip. In other words, a 10 percent home interview is a 10 percent sample of the dwelling units and, consequently, a sample of 10 percent of all trips made, including those to the CBD. This type of sample may be sufficient for the more general aspects of the transportation study, but there is some question as to its sufficiency for the detailed stratification necessary in the CBD parking analysis. By comparison, the data collected from a special parking interview can represent as much as 100 percent of the CBD trips. The actual percent interviewed would depend on the size of the area and the staff available.

A second disadvantage in the use of O–D data is the inherent underreporting of the nonhome based trips. The consequence of this shortcoming is manifested in the smaller number of intra-CBD trips reported using O–D data as compared with the intra-CBD trips tabulated from a parking study. There has been limited research in this area, but all the results have indicated an underreporting in the O–D data.

A third disadvantage is the handling of the external–internal trips. Usually the information gathered during the external interview is much more limited than that in the home interview portion and consequently, the data needed for the parking analysis is not available. Therefore, some method of approximation becomes necessary in handling these trips. This is not a problem in the areas having a small percentage of external–internal trips; but the larger this percentage becomes, the greater the magnitude of the problem. In the parking interview this problem does not occur as all interviews are conducted at the parking end and the data available are the same regardless of the origin of the trip.

A fourth disadvantage is the lack of enforcement data. During the usage study of the conventional parking analysis, information is collected on the numbers of vehicles double parked, parked in illegal spaces, or parked for greater than the allowable duration. Although such information usually is of little importance, it can be indicative of the degree of congestion in the area. Excessive double parking for example may indicate the need for more short-time parking in an area. Such information may also indicate an improper balance of facility types. For example, excessive parking at greater than the permissible durations may indicate the need for less short-duration spaces and more long-duration spaces.

On the other hand, there are several distinct advantages in using O–D data. The most obvious is the ease of data collection and related financial savings. As pointed out, most of the information needed is collected in the O–D survey and therefore parking data can be obtained by a computerized extrapolation instead of by a second lengthy interview, which would require the restaffing of interviewers, a second session of training, additional editing and coding, etc. Elimination of these repetitious steps would obviously be a financial savings.

A second advantage of using O–D data, is that the data is available for a 24-hour period. This allows the flexibility of permitting an analysis of the data within any desired time period. By comparison, the analysis based on the parking interview is confined to a previously determined time span and cannot be changed once the data are collected.

A third advantage of using O–D data is that all the information required is available for each observed vehicle; that is, there are no observations of parked vehicles with unknown data—a situation that frequently occurs in the parking study, especially if interviewing begins late in the day. For instance, if interviewing begins at 9 a.m., an auto-driver parked at 8 a.m. and remaining

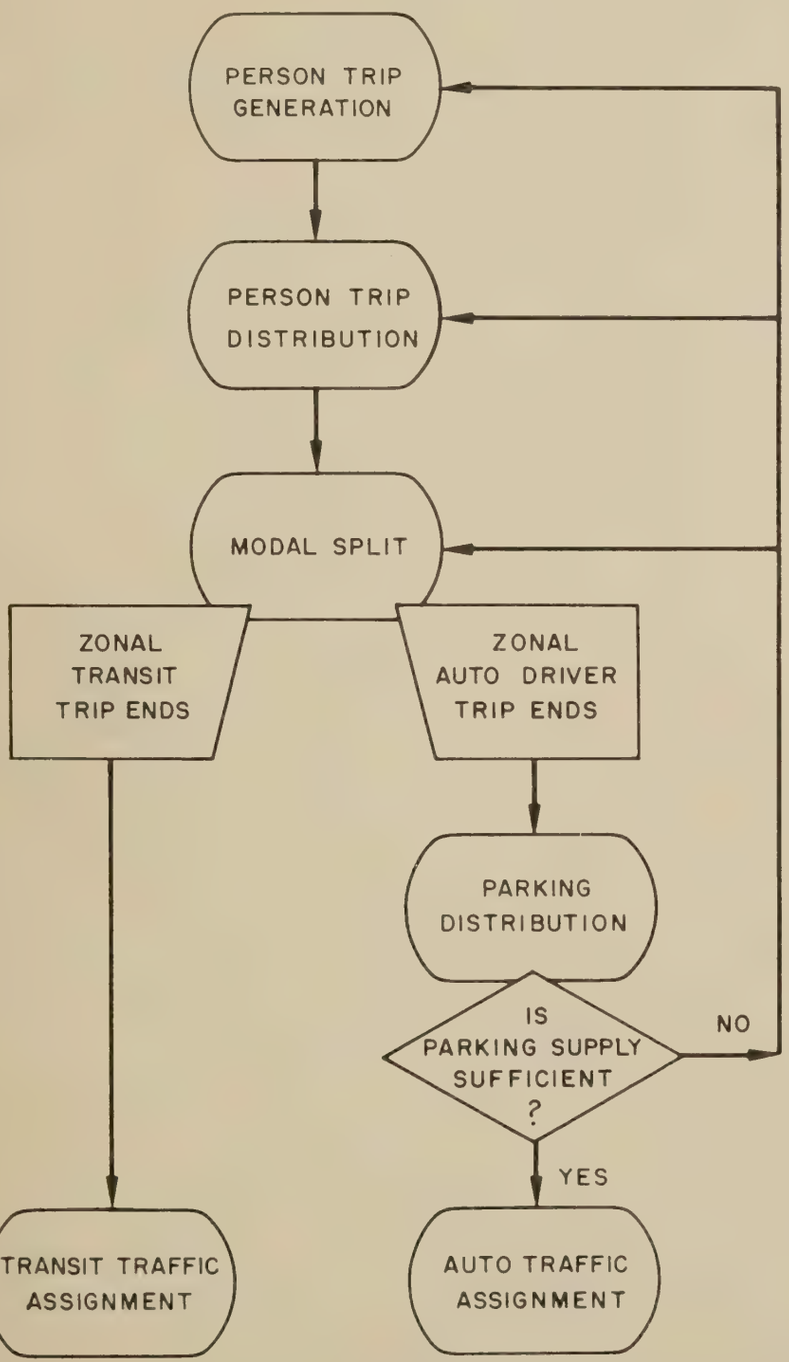


*Figure 6.—Phase sequence of planning process using a trip interchange modal split.*

parked all day would not be interviewed and the parking characteristics could not be obtained even though the vehicle is observed in the usage study. This cannot occur in the O–D data as the trip, if recorded at all, will provide the required information.

### Data analysis

Regardless of the procedure employed to collect the data, the analysis and the distribution process are basically the same. The data collection phase merely supplies the required data and is independent of the subsequent analysis. This is not true of the next two phases; data analysis and parking distribution are strongly interrelated. The type and the detail of the data analysis is dependent on the level of detail required as input in the parking distribution—the more complex the distribution, the more detailed the analysis.

As one of the initial tasks in the analysis will be the calibration of a computer model, the characteristics of parking must be reduced to a series of simple but logical mathematical relationships. In addition, other pertinent factors must be determined to facilitate a check on the validity of the model distribution. The detailed analysis is difficult to explain at this point because the details depend on the specifics of the model, but in general the following relations are required:

- Average parking durations for different purposes and different arrival times.
- Acceptable walking distances for different durations under various cost structures and various levels of congestion.
- Arrival of trips by purpose distributed by hour of arrival.

A more detailed discussion will be possible once the distribution model is fully defined.

### Model calibration

Before any hypothetical model can be used, it must be calibrated based on the existing data. The method of calibration must allow the distribution of the entire parking demand at farther than acceptable walking distances, and provide a check to determine how closely the model distribution compares with the actual parking distribution. Based on this comparison, adjustments can be made in the theoretical model to better reproduce the base year conditions.

After calibration the model is ready to be used to evaluate either existing or future parking conditions, or to evaluate the effects of changes in either cost structure or parking supply within the CBD. As a tool within the transportation planning process, it can also be used to evaluate the effects of changes in level of transit service, the effect of introducing a fringe parking program, or the effect of major land use changes.

### Final report

The parking study report should provide a clear-cut analysis of the parking situation as it exists in the base year and as it will exist in the horizon year based on a forecast of future trips. The report should include a breakdown of the type and general location of parking; but more important, it should show the effects of changing the existing parking supply characteristics, costs, or durations; of increasing or decreasing the number of spaces available; of changing the amount or level of transit service; or of introducing fringe parking. In other words, the report should present a series of comparative analyses based on the different alternate parking plans possible within the transportation system.

## *Basic Relations*

The parking phenomena is based on the laws of supply and demand, where supply is the total number of spaces available within a specified area and demand is the desire to park at a specified location. However, unlike a true supply and demand situation, this basic relationship is confounded by a third variable, usage, where usage reflects the actual location of parking.

At first it might seem that demand and usage are identical, but closer observation shows that this is the exception rather than the rule. Demand is the desire to park based solely on the location of the trip destination, whereas usage reflects the desire to park close to the destination, but within the limitations imposed by available supply, and the desire to park at a reasonable cost. Thus, demand is a constant, reflecting only the desire to park at the trip destination location, whereas usage is a variable that depends on the conditions

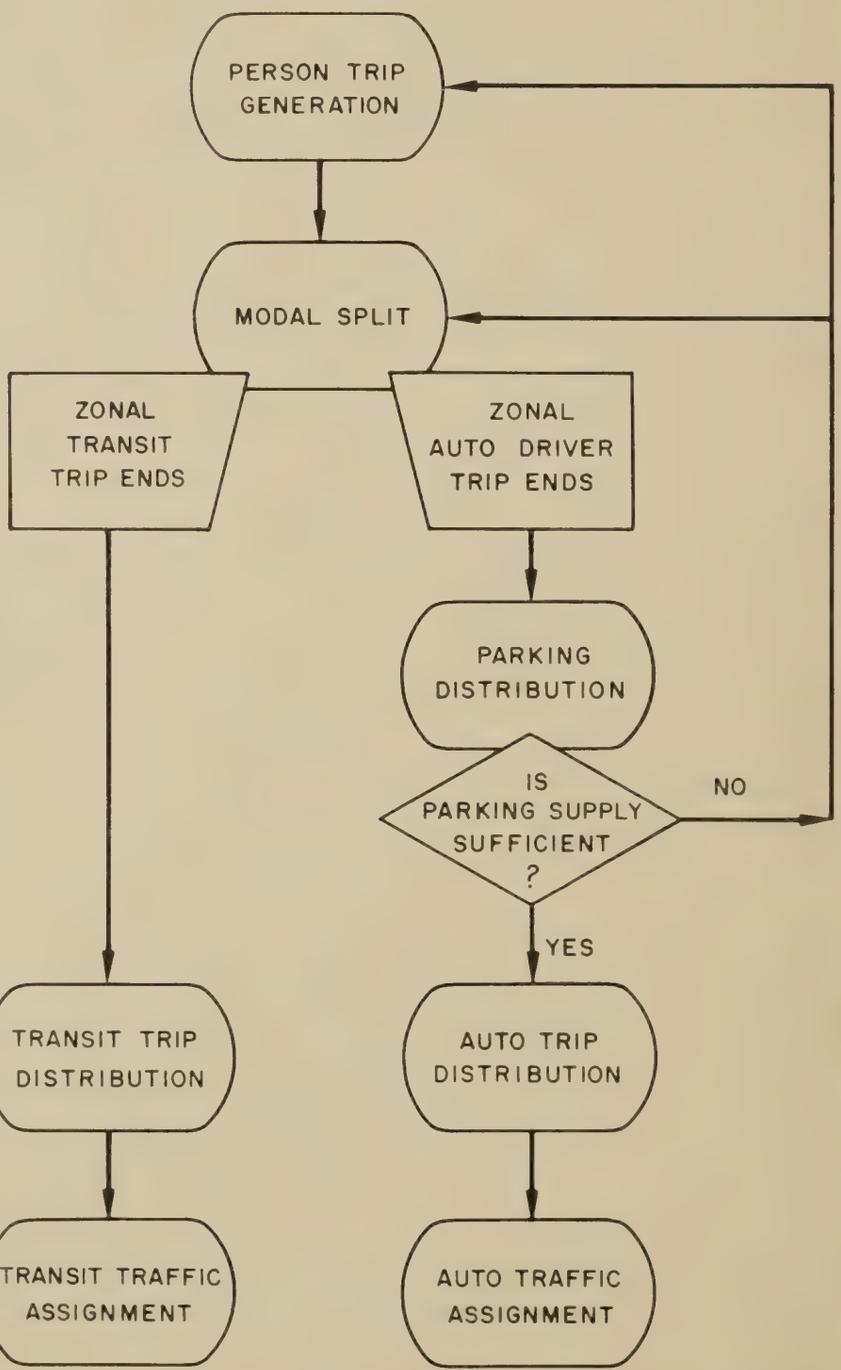


*Figure 7.—Phase sequence of planning process using a trip-end modal split.*

of the terminal area, the characteristics of the trip, and the characteristics of the tripmaker.

Under a deficient condition, in which demand exceeds the supply, the maximum usage is restricted by the supply, or the total spaces available. For this condition, demand exceeds both supply and usage, and the excess demand must be satisfied in an adjacent area. On the other hand, under a surplus condition, in which supply is greater than demand, maximum usage is restricted by demand, or the desire to park at that location. Under an ideal condition, usage will equal demand. However, if the supply at this location is undesirable—excessive parking cost—then the tripmaker may still choose an adjacent area to park and usage will be less than demand. Conversely, if the supply is very desirable, the area may attract adjacent demand, and usage would be greater than demand but limited to the available supply.

**Choice of analysis area**

Although full understanding of the concept of usage and how it relates to supply and demand is one of the key factors in the analysis of parking conditions, consideration also must be given to the choice of analysis area. This choice is extremely important, as the results of the analysis will change with differences in the choice of area.

The CBD as a single areal unit is usually quite large and encompasses both the heavily congested core areas where parking supplies are limited, and the fringe areas where parking supplies are overabundant but inconveniently located. Therefore, when the CBD is taken as a single unit, the overabundant supply of the fringe area more than balances the deficiencies of the core areas and results in an overall surplus. This apparently ideal end result would occur even though serious deficiencies might exist in certain specific areas within the CBD.

Having established that a smaller areal unit is needed, the next logical consideration would be to analyze the data by individual blocks. This type of analysis would certainly isolate individual areas with deficiencies; however, it could also produce misleading results. The fact that an individual block exhibits a parking deficiency is not always an indication of a critical parking problem. If one or more of the adjacent blocks can accommodate the excess demand, then these several blocks—considered as an areal unit or composite area—will exhibit a satisfactory situation. Usually the analysis of groups of blocks eliminates individual block deficiencies; it is only when the composite area experiences a deficiency that the parking problem is considered critical.

**Use of composite area**

The use of a *composite area* in the parking analysis can be justified by discussing the factors that influence the tripmaker's final choice of a parking space. The basic premise is that a tripmaker desires to park as quickly as possible along the route of travel and as close to his destination as possible, but also desires to keep his parking cost at a minimum. To explain the parking phenomenon fully, the ramifications of these conflicting desires must be analyzed under both surplus and deficient parking conditions.

It is assumed that route orientation, the desire to park along the route of travel, can be ignored when discussing composite area. This assumption is based on two considerations. First, in trying to fulfill his parking desires, the tripmaker soon finds that it is necessary to deviate from the actual route of travel. This usually happens either because spaces close to the destination are not available along the route of travel or because those that are available are excessively priced. The willingness to deviate from the route of travel seems to indicate that low parking cost and location close to the destination are more important factors to the tripmaker than route orientation. Second, if a given block is equally accessible from all directions, the composite area analysis will not be affected by an individual route orientation. This is true because the composite area usage is determined by the aggregation of individual tripmakers with route orientation in all directions. These two facts indicate that route orientation can be ignored when composite area is being determined. Therefore, to understand the parking phenomenon, the remaining conflict between parking close to the destination and keeping parking cost to a minimum must be analyzed under both surplus and deficient conditions.

Under a surplus condition in which parking is plentiful and costs are minimal, all trips would terminate as close to the destination as possible or in the demand area. However, if the same conditions existed but a substantial cost were imposed upon parking spaces near the destination, tripmakers would seek parking in other areas. Because of this, it can be assumed that under surplus conditions, the tripmaker is willing to travel a longer distance merely to save or reduce the cost of parking. Under a deficient condition in which the parking demand exceeds the supply, the tripmaker will probably be unable to park near the destination, and he *must* and usually will travel some distance until he can find the closest available parking space. From this it can be assumed that a tripmaker is also willing to travel a certain distance in search of an available parking space.

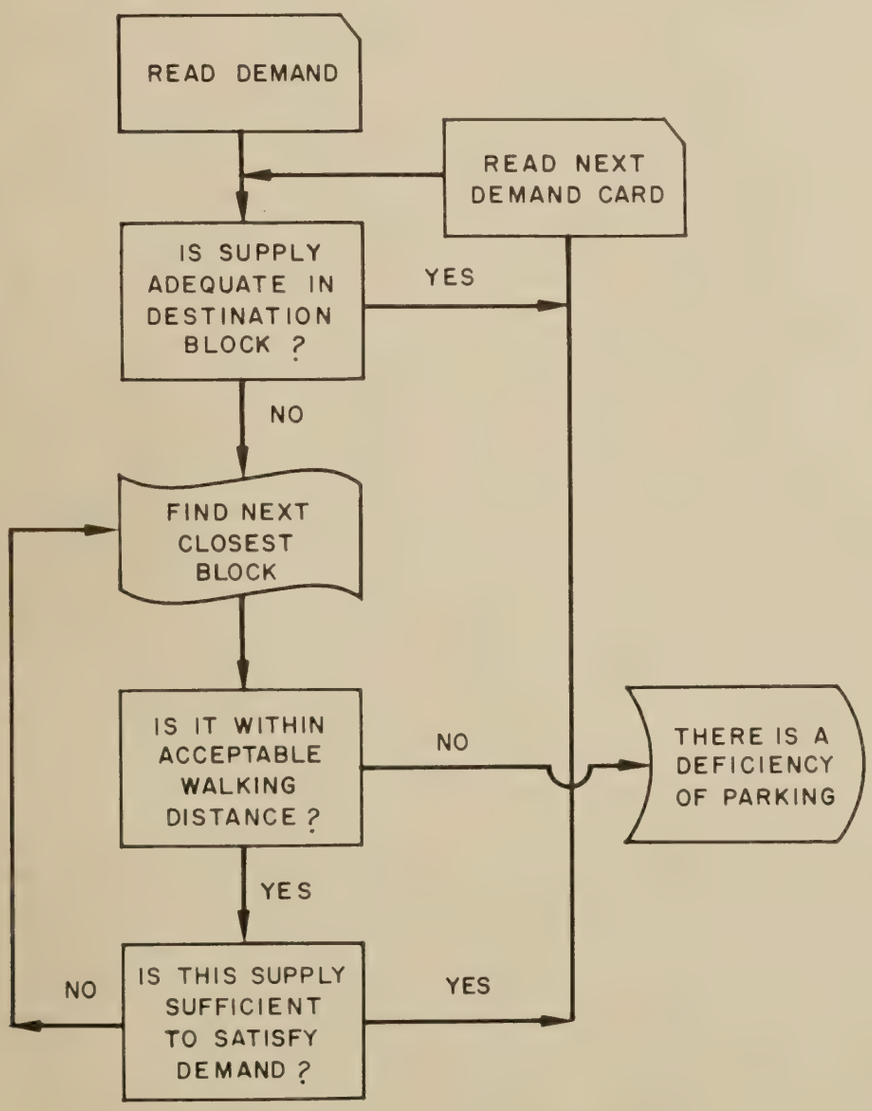


*Figure 8.—Steps in distribution of parking demand to supply.*

Although under both conditions the tripmaker apparently is willing to travel a certain distance to satisfy his parking desires—whether by choice or by necessity—there is a maximum distance that anyone is willing to travel, and it is the area within this maximum travel distance that can be defined as the composite area for any desired destination. Therefore, it is logical to postulate the concept of an aggregate or composite area in determining parking conditions within the CBD.

**Acceptable walking distance**

Next, it is necessary to consider the factors that influence the maximum travel distance and also to determine whether these factors are the same under surplus, or free choice, conditions as they are under deficient, or forced, conditions. Under each condition, this distance is called the *maximum acceptable walking distance,* and as the name implies, is the maximum distance that a tripmaker is willing to walk between the parking space and the ultimate destination.

Unfortunately, the criteria behind determination of this distance are many and varied. Some of these criteria reflect characteristics of the trip, some the characteristics of the tripmaker, and some the conditions within the composite area. Generally, those characteristics relating to the trip and to areal conditions are easier to isolate and analyze; consequently, the characteristics of the tripmaker are usually ignored.

One of the trip characteristics most easily identified is the relation between walking distance and parking duration. Generally, the longer the parking duration, the farther the tripmaker is willing to walk. Studies also indicate a definite relation to exist between walking distance and trip purpose. However, these relationships can probably be explained by the interrelation between trip purpose and duration. A work trip, which is usually of long duration, would have a long acceptable walking distance; whereas a shopping trip, which is of shorter duration, would have a shorter acceptable walking distance.

Another important consideration is the cost of parking within the destination area. As was pointed out, a tripmaker is usually willing to travel to avoid a parking cost. Therefore, the acceptable walking distance will probably be longer when the tripmaker is searching for a free or low-cost parking space than it would be when he is searching for a high-cost parking space. That is, he is willing to walk a little bit farther to avoid paying a parking fee or to reduce the parking cost.

The previous statements have been general and have been made without regard to the parking conditions within the composite area. Tripmakers' reactions will probably differ depending on whether the choice is being made under deficient or surplus conditions. Under surplus conditions the choice of parking location depends entirely on the desires of the tripmaker; whereas under deficient conditions, the tripmaker is forced to travel until a parking place is found or until he has reached the maximum acceptable walking distance. Hence, it is assumed that the tripmaker will tolerate a greater walking distance under deficient conditions than he will under surplus conditions. For all conditions it has been assumed that the tripmaker always prefers to use his automobile and that he is unwilling to change his mode of travel because of deficient parking.

Because of the numerous considerations behind the determination of the maximum distance, it is difficult to choose a simple definition for composite area. Actually, each destination block has several definable composite areas in which each definition depends on the parking duration, parking costs, and composite area parking conditions. If the possible characteristics are limited only to long or short parking durations, high or low parking costs, and deficient or surplus parking conditions, then eight different composite-area definitions are possible for a given destination area. This does not mean that there will be eight unique definitions, but that trip and areal characteristics must be determined before the composite area can be defined. For example, a classification of characteristics could be as follows:

| *Characteristics* | *Composite area (walking distance, blocks)* |
|---|---|
| Surplus: | |
| Short duration: | |
| Low cost | 3 |
| High cost | 2 |
| Long duration: | |
| Low cost | 4 |
| High cost | 3 |
| Deficient: | |
| Short duration: | |
| Low cost | 4 |
| High cost | 3 |
| Long duration: | |
| Low cost | 5 |
| High cost | 4 |

In this example, the longest tolerable walking distance would be associated with a stop of long duration, low parking cost under deficient conditions (5 blocks). The shortest tolerable walking distance would be associated with a stop of short duration, high parking cost under surplus conditions (2 blocks). Stops of short duration, low parking cost under surplus conditions; long duration, high parking cost under surplus conditions; and short duration, high parking cost under deficient conditions all have the same composite area (3 blocks).

**Supply-demand-usage relations**

Previous statements concerning supply, demand, and usage have been greatly oversimplified as only relations within individual blocks have been discussed. When the relations are analyzed using the composite-areas concept, the analysis not only becomes more complex but also more realistic.

Under a deficient condition, the statement that choice of location is not available is only a half truth. There can be a choice, but only until all the available parking supply within the composite area has been saturated. Therefore, during the early stages of congestion buildup, the tripmaker can choose from any of the locations available within the destination block or the blocks of the composite area; but when all the available supply has been used in the destination block, the tripmaker is forced to use only the available supply in adjacent blocks within the composite area. This process continues with the number of choices decreasing as blocks within the composite area become saturated and it terminates when all available spaces have been used. It is at this point that all choice ceases and block usage, as well as composite usage, equals supply. Until this point is reached there are varying degrees of choice of location within the composite area.

Under a surplus condition, the internal workings of the composite area are very similar to those under ultimately deficient conditions, except that the point is never reached where all blocks within the area are saturated. There may be several blocks in the composite area that reach saturation before all demand is satisfied, and as each block becomes saturated, the choice becomes limited only to those blocks that still have surplus space available. The main distinction between the two conditions is that under surplus conditions, the total demand is satisfied before the composite area supply is saturated, whereas under deficient conditions, the supply is saturated before the demand is satisfied.

## *Current Parking Analysis*

The current status of the parking analysis and its relation to the comprehensive transportation planning process is best evaluated by splitting the analysis into three separate phases: Data collection, data analysis, and application of findings. It is necessary to consider these phases individually as they have progressed with varying degrees of satisfaction.

**Data collection**

Although any complete parking analysis would depend on precision in all phases, only the data collection phase has been conducted with any degree of satisfaction. At present, the following data-collection methods have been widely documented and are in popular use:

*Parking supply inventory.*—This method constitutes a survey that summarizes and classifies the supply of curb and off-street parking spaces within a study area. Curb spaces are inventoried by one or more teams of observers who traverse all streets to estimate or measure the number of different types of restricted and unrestricted spaces. Off-street lots and garages are visited and spaces are counted and classified by type. At this time parking fees are also determined. The inventory is tabulated by blocks or sections within the area.

*Parking usage studies.*—These studies include the space-occupancy study and the parking-duration study as described below:

- The space-occupancy study is conducted to measure the amount of parking-space occupancy at curb and off-street facilities, t

evaluate the use of loading zones, and to observe the extent of illegal parking. Curb street occupancy is measured by observing each block at regular intervals and counting the number of spaces occupied, the number of commercial vehicles in loading zones, the number of parked vehicles in prohibited or loading zones, and the number of vehicles double parked. Generally one count an hour is made, but a higher frequency may be necessary if sharp fluctuations in demand exist. Off-street space occupancy may also be obtained by counting vehicles at regular intervals; however, if recording traffic counters are available, they can be used. Time-punched parking receipts, if available, are also good sources for determining occupancy in off-street spaces.

• The parking duration study is conducted to measure the length of time that vehicles are parked at curb or off-street facilities, and to compute the parking turnover rate. Curb-parking duration is obtained by observing block faces at frequent intervals and recording license plate numbers or other identifying data for each vehicle parked. It is desirable to cover all the spaces within the study area, but if 100 percent coverage is not feasible, a sample of at least 80 percent can be used. Off-street parking duration is most easily obtained from parking tickets if they have arrival and departure times. For facilities not using tickets, the duration can be measured either by continuous observation or by recording license plates at intervals.

*Parking demand studies.*—In this method surveys are conducted to determine the distance that vehicle occupants walk between their parking space and their ultimate destination, the purpose for which the trip was made, the ultimate destination, and the origin of the vehicular trips to the parking space. The two procedures now used are interview surveys and post card surveys.

• An interview is conducted with all auto drivers as they park at curbs or off-street spaces. Such procedures usually require a large staff and therefore the area is usually subdivided and surveyed a portion at a time. At off-street facilities, interviewers are placed at all entrances and exits.

• A postal card survey allows collection of similar data with less manpower. Post cards are placed on windshields of all vehicles—both curb and off-street. The value of this type of survey is limited by the fact that expansion of the data on the cards returned is difficult.

*Cordon counts.*—In this method the total level of parking demand within an area is estimated by measuring the accumulation of total vehicles in the area. This information can be combined with parking-accumulation data to determine parking and traffic movements in the area.

*Land use inventory.*—This method is used to estimate the level of parking demand created by the traffic generating potential of different types and intensities of land use. The inventory will vary with the type of parking problem under investigation.

**Data analysis**

Although numerous agencies have gone through the mechanics of collecting and summarizing data, only a few have analyzed the data with any degree of satisfaction. The analysis currently performed would be more correctly classified as *data presentation*, and usually is more concerned with the development of parking characteristics than with the development of relations among supply, demand, and usage.

A typical report would include the following information:

• A complete listing of parking spaces available by location and facility type, including parking cost.

• Accumulation curves by total vehicles, by trip purpose, and by facility types.

• Duration of parking and turnover rates by trip purpose and by facility type.

• Walking distance by purpose and by facility type.

• Tables indicating location of parking generators.

• Tables indicating origin and ultimate destinations of trips.

• A comparison of existing supply and demand by block or sector showing location of surplus and deficient locations.

• A projection of supply and demand by block and an indication of future surplus and deficient locations.

The first six items usually constitute the bulk of the report, and although presented in great detail they are of value only in illustrating some of the characteristics of parking. As presented in the report and used in the analysis, they have little value in determining the location of parking deficiencies or in explaining the reasons for these deficiencies. On the other hand, the last two items, which in essence are the objectives of the analysis, are usually reduced to a couple of useless and poorly documented pages.

The determination of the locations of deficient conditions is usually handled on a one-shot daily basis; that is, the total daily block demand, in space hours, is compared with the available block supply, in space hours, and the numerical difference determines a surplus or deficient condition. In some areas, block deficiencies are being analyzed in light of the surplus existing in adjacent blocks. Although such analyses are well founded, the specific applications are usually of questionable validity. Also meager attempts have been made to explain some of the reasons for deficient conditions, but owing to the form of the analysis the reasoning is merely speculative.

The future forecasting of parking conditions, if done at all, is usually the poorest aspect of the analysis. The forecasts are usually based on factoring techniques, but the validity of many of the assumptions is questionable.

**Application of findings**

The last section of the report is usually a series of recommendations to provide guidance in planning programs to eliminate the areal deficiencies. These recommendations can range from a general list of suggestive measures to a detailed program of site construction and priorities. However, regardless of the detail, it is never known whether any of the findings will be used. In fact, because the entire analysis is independent of the comprehensive planning process, it is never known whether it will eventually be incorporated into the ultimate planning.

## *Proposed Parking Project*

Previous findings indicate that a project is needed to evaluate some of the possibilities of improving both the coordination of parking within the comprehensive transportation planning process and the general quality of the parking analysis. The proposed project is divided into three major phases: (1) The organization of a series of programs capable of computing the parking characteristics needed for all ensuing analyses; (2) the comparison of computed parking characteristics using O–D data with those computed characteristics using parking data; and (3) the organization of a program that is capable of distributing parking demand to available supply. These phases are described in the following paragraphs.

**Phase 1**

In the first phase of the proposed project a series of basic programs will be written. The primary program will facilitate the extrapolation of the necessary parking data from O–D trip cards. In essence it will contain a linking system that links the CBD inbound trip with the corresponding outbound trip and produces one record with the desired parking information.

The second major program will consist of a series of routines to perform the analyses usually required in a parking study; that is, data tabulation, stratification, calculation, etc. Operation of this program will be independent of the method of data collection—it will operate either with parking study data or with O–D parking data. Additional routines would also be available to provide the characteristics needed for the distribution model.

**Phase 2**

A comparison will be made in the second phase to determine whether the O–D survey can supply the necessary data for a parking analysis. An area having both O–D data and a comprehensive parking study will be selected. Using the programs from phase 1, the parking characteristics will be computed and compared with those found in the parking study report. A similarity in the general characteristics from both analyses would tend to validate using O–D data for the parking analysis.

**Phase 3**

In the third phase a program will be written to simulate the distribution of parking demand to the supply available in the CBD. The distribution will be based on the relations discussed in the text and, in general, will follow the procedure explained. However, in the more complex procedure, the following logic will be applied to the distribution.

During each hour a certain number of autos arrive at a given block for a desired purpose and for a given parking duration. At this point an initial search is made to determine whether free spaces of the required duration are available in the destination block. If there are enough spaces to satisfy the demand, the distribution is terminated and the next block demand is read. However, if there are not enough spaces available of the required duration, a search is made to determine whether free spaces of a greater duration than required are available in the destination block. If there are, and the demand is satisfied, the distribution is terminated and the next block demand is read. However, if there are not enough spaces available, a search is begun for all the free spaces available within the other blocks of the composite area.

At this point, the maximum acceptable walking distance must be determined. When the first closest block is chosen, a check will determine whether it is within the acceptable walking distance. If it is, a search is made to determine whether any free spaces of the required duration are available. If there are, and the demand is satisfied, the next block demand is read. However, if the supply is insufficient, a search is made to determine whether spaces of a longer duration are available in this block. If there are, and the demand is satisfied, the distribution is terminated and the next block demand is read. However, if the supply is insufficient, the next closest block is analyzed. This process is continued until all the blocks in the composite area within acceptable walking distance are explored or until all the demand is satisfied.

If there is still unsatisfied demand, it is assumed that the driver must accept a pay-parking space as all the available free spaces have been occupied. Therefore, the searching process is returned to the destination block to determine whether pay spaces of the required duration are available. If enough spaces are available to satisfy the demand, the distribution is terminated and the next block demand is read. However, if the supply is insufficient, a search is made to determine whether spaces of longer duration are available in the destination block. If enough spaces are available to satisfy the demand, the distribution is terminated and the next block demand is read. However, if there is still unsatisfied demand, a search similar to the previous one is made of all remaining pay spaces in the composite area. For this search, a new maximum acceptable distance is determined—this time for a paid parking trip of the required duration—and the search process continues until all the demand is satisfied or all the available spaces have been used.

At this point, if the demand is still unsatisfied, a special search is made, in which it is assumed that parking must be accomplished under a deficient parking condition, and that the driver must be willing to walk an even farther distance if he wishes to complete the trip. In other words, he has passed from the realm of free choice to that of necessity. Accordingly, another search is made for free space and then for pay spaces, but this time an acceptable walking distance of approximately one block longer is used.

If the demand is still unsatisfied, the composite area is assumed to be deficient because at this point in the distribution every available space—free or pay—within acceptable walking distance has been explored; and the trip-maker, unwilling to travel any farther, will begin to research the composite area causing traffic congestion.

This process is continued block-by-block and purpose-by-purpose for each hour within the duration of the parking study. Upon completion of the distribution, the analytical information available can be as simple or as sophisticated as desired. At a minimum, the amount of the surplus demand gives the degree of deficiency in the area, and the time of day and magnitude of the parking duration reveals type of deficiencies that exist.

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# NEW PUBLICATIONS

The Bureau of Public Roads has recently published three documents. These publications may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, prepaid. The following paragraphs give a brief description of each publication and its purchase price.

### *Highway Statistics, 1966*

*Highway Statistics, 1966*, is the 22d issue of the annual compilation of statistical and analytical tabular matter pertaining to Federal-aid for highways. This 186-page publication ($1.25 a copy) presents information, primarily in tabular form, on motor fuel, motor vehicles, driver licensing, highway-user taxation, State and local highway financing, road and street mileage, and Federal-aid for highways.

### *Capacity Analysis Techniques for Design of Signalized Intersections*

*Capacity Analysis Techniques for Design of Signalized Intersections*—Reprinted from August and October 1967 issues of PUBLIC ROADS, A Journal of Highway Research (45 cents a copy)—are presented for the graphic solution of capacity problems related to signalized intersections. The procedures are based on a set of charts consisting of 20 nomographs, which were devised by the author, Jack E. Leisch, in 1950, to simplify the computational procedures of the 1950 Highway Capacity Manual. They were presented in PUBLIC ROADS, A Journal of Highway Research, in 1951, and were acclaimed by those concerned with intersection design. Publication of the 1965 Highway Capacity Manual has provided a revised and comprehensive basis for capacity computations, and the author has again filled the need for a graphic procedure incorporating current knowledge. The original charts have been updated and new charts prepared to cover capacity procedures for which calculations previously required extensive application of judgment. The information presented provides a graphic procedure for the capacity analysis of most signalized street and highway intersections. Full discussion of the principles and procedures in the application of the charts, in addition to sample problems, have been included.

### *Highway Research and Development Studies, Using Federal-Aid Research and Planning Funds*

The 1967 issue of *Highway Research and Development Studies Using Federal-Aid Research and Planning Funds* may be purchased for $1.00 a copy. The studies listed are those approved in the Office of Research and Development, Bureau of Public Roads, FHWA, for fiscal year 1968, and calendar year 1967, as of July 1, 1967.

The information has been grouped by the seven major technical goals of the National Program of Research and Development in Highway Transportation. These major technical goals are:

- Definition of underlying requirements for highway transport,
- Analytic definition of complex traffic movements,
- Analysis of essential components of highway transport,
- Development of methods for reliable forecasting of demand for highway transport,
- Development of methods for increased capacity, control, and safety in traffic movement,
- Development of techniques for more precise structural design and incorporation of new materials and structural concepts,
- Development and application to new technology to location, design, construction, and maintenance processes.

An eighth grouping includes miscellaneous projects of local, regional, or national importance. Data are also presented on the objective of each study, the conducting agency, and the funding for each study.

This year's edition contains a new feature—a section listing available reports on Federal-aid highway research studies. In addition, a newly revised and amplified foreword briefly explains the makeup and operation of the Federal-aid highway research and development program, and describes how the content of the publication is organized. The expanded foreword is intended not only for Federal Highway Administration personnel, but also to guide those outside the Government who are interested in the program and may desire to participate in it.

# THE NATIONAL SYSTEM OF INTERSTATE AND DEFENSE HIGHWAYS

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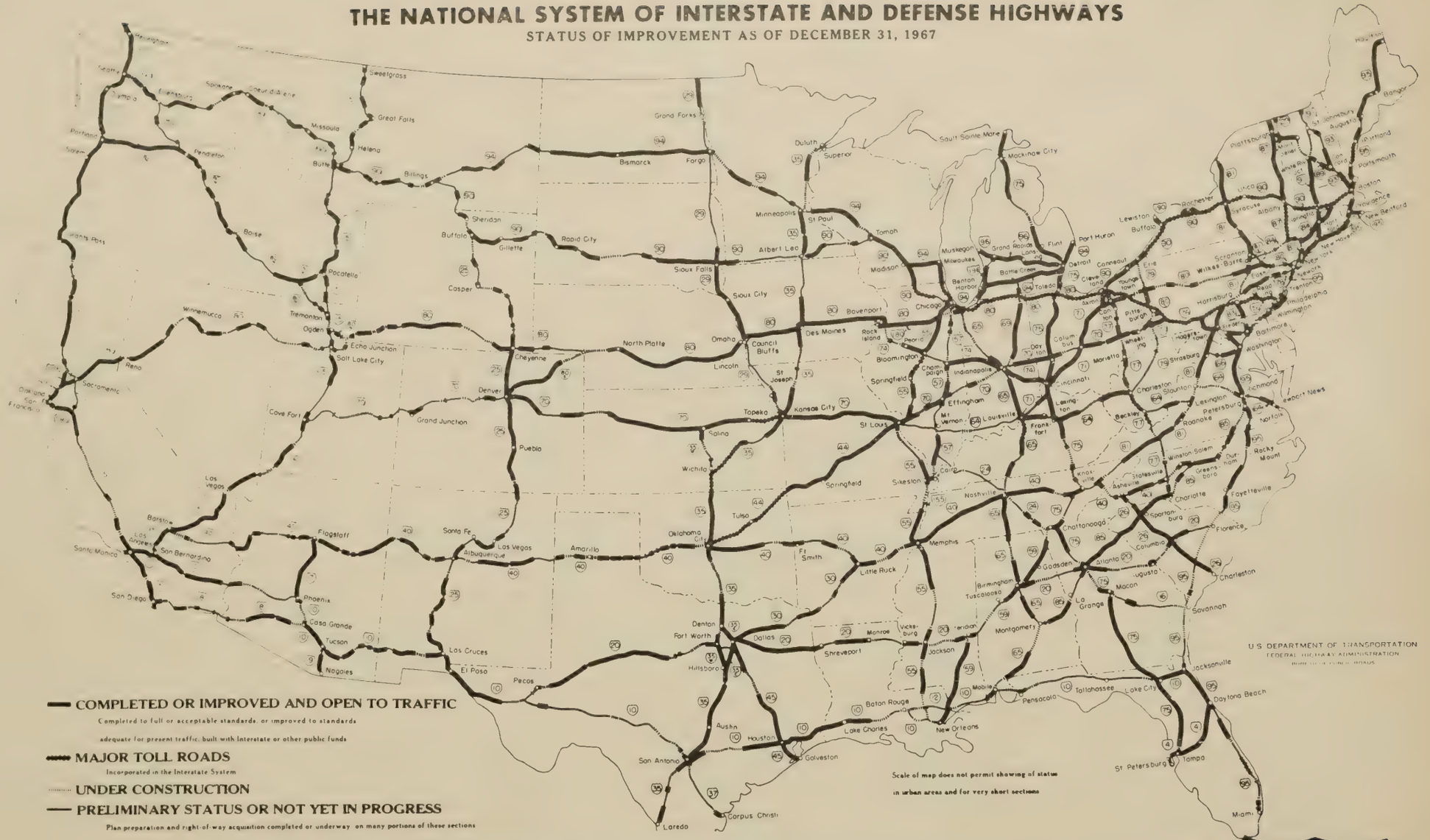
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